Three Essays on the German Capital Market

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PART I

Introduction

Inhalt

1 Motivation

Das Ziel der vorliegenden Dissertation ist es, durch drei selbstständige wissenschaftliche Aufsätze einen wichtigen Beitrag zum Verständnis der Funktionsweise des deutschen Aktienmarktes zu leisten. In allen drei Aufsätzen stehen eigene empirische Untersuchungen im Mittelpunkt, es handelt sich also um Beiträge zum relativ jungen Wissenschaftsgebiet „Empirische Kapitalmarktforschung“.[1] Empirische Untersuchungen zur Funktionsweise der Kapitalmärkte werden in den USA zwar bereits seit ca. 100 Jahren durchgeführt. Vor 1970 wurden jedoch nur wenige Arbeiten verfasst.[2] Erst nach 1970 stieg die Anzahl der empirischen Untersuchungen zum US-amerikanischen Markt stark an. Die Anzahl der empirischen Untersuchungen zum deutschen Markt nahm erst Anfang der 1990er Jahre zu, liegt jedoch – auch bei relativer Betrachtung – weit unter der Anzahl der Arbeiten zum US-amerikanischen Markt. Hierfür dürften die folgenden Gründe ausschlaggebend sein:

- Die Zahl der Wissenschaftler, die in Deutschland empirisch auf dem Gebiet der Kapitalmärkte arbeiten, ist im Vergleich zu den USA gering.
- Nur ein Teil der Wissenschaftler in Deutschland konzentriert sich auf den deutschen Kapitalmarkt, viele tragen zur Erforschung des US-Kapitalmarktes bei oder erstellen länderübergreifende Studien.
- Im Vergleich zum US-amerikanischen Kapitalmarkt ist die Verfügbarkeit qualitativ hochwertiger Daten für den deutschen Kapitalmarkt eingeschränkt.

Als Folge der relativ geringen Zahl von Arbeiten, die sich auf den deutschen Kapitalmarkt konzentrieren, sind die wissenschaftlichen Erkenntnisse über diesen Markt vergleichsweise gering. Solche Erkenntnisse sind aber aus einer Reihe von Gründen wichtig:

- Ergänzende und weiterführende Studien zum deutschen Kapitalmarkt sind notwendig, um die bisherigen, zum Teil widersprüchlichen empirischen Ergebnisse zu diesem Markt zu prüfen bzw. zu erhärten (vgl. Abschnitt 5).
- Aufgrund einer Vielzahl von empirischen Studien zum US-amerikanischen Kapitalmarkt dominiert derzeit die Meinung, dass das CAPM, insbesondere in den USA, nicht gilt bzw. empirischen Tests nicht standhält (vgl. Abschnitt 1.2). Gleichzeitig wird das CAPM in Deutschland unter anderem von der Bundesnetzagentur zur Schätzung der Eigenkapitalkosten

[1] Der hohe wissenschaftliche Stellenwert der Empirischen Kapitalmarktforschung wird u. a. durch die relativ hohe Anzahl von Publikationen und Wissenschaftlern, die sich mit diesem Thema intensiv auseinandersetzen, verdeutlicht.

[2] Eine der frühen Studien zur langfristigen Performance von Aktien und festverzinslichen Wertpapieren wurde von Macaulay (1938) verfasst. Diese Arbeit wird hier aufgrund ihrer wirtschaftshistorischen Bedeutung exemplarisch genannt, schließlich wurde in dieser Arbeit unter anderem das Durations-Maß, die Macaulay-Duration, eingeführt. Eine weitere wichtige Arbeit von Smith (1924) vergleicht die Performance von festverzinslichen Anleihen (Bonds) mit Aktien (Common Stocks). Smith kommt für den Zeitraum vor 1923 zu dem Ergebnis, dass Aktien zumeist einen höheren Ertrag erzielten als Anleihen.

der zu regulierenden Unternehmen, von den Gerichten im Rahmen von Squeeze-out-Verfahren und seitens der Unternehmen zur Schätzung der Eigenkapitalkosten verwendet. Vor diesem Hintergrund stellt sich die Frage, ob das CAPM in Deutschland gilt?

- Die derzeit wichtigsten Alternativen zum CAPM sind das empirisch motivierte Dreifaktorenmodell von Fama/French (1993) sowie das Vierfaktorenmodell von Carhart (1997). Für den US-amerikanischen Kapitalmarkt wurde in einer Vielzahl von Studien gezeigt, dass diese Modelle die Renditen von Aktien besser erklären als das Standard-CAPM. Für Deutschland gibt es bisher hingegen nur wenige empirische Studien, die sich mit der Fragestellung auseinandersetzten, ob das CAPM in Deutschland ebenfalls um Faktoren wie beispielsweise für Size und/oder Buchwert-/Marktwert erweitert werden soll.[3]
- Soll in Deutschland ein nationales (deutsches), ein regionales (europäisches) oder ein globales CAPM bzw. empirisches Kapitalmarktmodell verwendet werden? Fama/French (2011) vergleichen regionale und globale empirische Kapitalmarktmodelle miteinander. Hierbei kommen Sie zu dem Ergebnis, dass „[g]lobal models fare poorly in our tests, which opens the door for local [regionale] models." (Fama/French 2011, S. 4)
- In empirischen Studien zum US-amerikanischen Markt werden in der Regel wertgewichtete Aktienportefeuilles als Proxy für das Marktportefeuille verwendet.[4] Diese Portefeuilles werden durch die Aktien des NYSE dominiert. Die Aktien des Amex und NASDAQ, welche zwar zahlreich, aber im Vergleich zum NYSE relativ klein sind, haben hingegen nur einen geringen Einfluss auf wertgewichtete Marktportefeuilles. In Deutschland gab es traditionell drei Marktsegmente, den Amtlichen Markt, den Geregelten Markt und den Freiverkehr.[5] Hinzu kommt, dass es in Deutschland bis heute mehrere Börsenplätze gibt, wobei Frankfurt seit geraumer Zeit der wichtigste Börsenplatz ist. In Studien zum deutschen Kapitalmarkt werden zumeist der CDAX, DAFOX und die Stehle/Hartmond-Reihe verwendet.[6] Bis heute ist jedoch unklar, ob das deutsche Marktportefeuille alle deutschen Aktien, also alle Börsen und Marktsegmente, oder nur die Aktien bestimmter Marktsegmente und/oder Börsen berücksichtigen soll. Beispielsweise war der Neue Markt für viele Beteiligte ein großes Desaster,

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[3] Untersuchungen hierzu werden für den deutschen Kapitalmarkt u. a. von Ziegler et al. (2007) und Artmann et al. (2012a) durchgeführt. Beide kommen zu dem Ergebnis, dass das Dreifaktorenmodell von Fama/French (1993) die Renditen deutscher Aktien besser erklärt als das Standard-CAPM. Allerdings schreiben Artmann et al. (2012a, S. 24) auch, „[…] we find the Fama-French model to do a poor job in explaining the cross-section of average stock returns in Germany."

[4] Beispielsweise verwenden Fama/French (1992) das wertgewichtete Portefeuille aller NYSE-Aktien, Ang/Chen (2007) und Fama/French (2006) das wertgewichtete Portefeuille aller NYSE-, Amex- und NASDAQ-Aktien, Fama/French (2004) das CRSP wertgewichtete Portefeuille aller US-amerikanischen Aktien. Oftmals wird auch der S&P 500 Index verwendet. Gelegentlich werden gleichgewichtete Portefeuilles herangezogen, beispielsweise verwenden Black/Jensen/-Scholes (1972) und Fama/MacBeth (1973) ein gleichgewichtetes Portefeuille aller NYSE-Aktien.

[5] Derzeit gibt es in Deutschland zwei Marktsegmente, den Open Market und den Regulierten Markt. Zwischenzeitlich gab es in Frankfurt noch den Neuen Markt.

[6] Der DAFOX deckt den Amtlicher Markt in Frankfurt ab. Der CDAX umfasst bis September 1998 nur den Amtlichen Markt in Frankfurt, anschließend zusätzlich den Geregelten Markt in Frankfurt und den Neuen Markt. Seit November 2007 bezieht sich der CDAX auf den Regulierten Markt in Frankfurt. Die Stehle/Hartmond-Reihe umfasst bis 1988 die Aktien des Amtlichen Marktes in Frankfurt, anschließend basiert sie auf dem CDAX.

insbesondere für die Anleger.[7] Die Einbeziehung des Neuen Marktes hätte einen erheblichen Einfluss auf die Performance des deutschen Marktportefeuilles zwischen 1998 und 2003.

- Die Ergebnisse für den amerikanischen Kapitalmarkt sind möglicherweise nicht uneingeschränkt auf andere Kapitalmärkte übertragbar. Dimson/March/Staunton (2002, S. 3) argumentieren, dass die US-amerikanische Wirtschaft im Zeitraum von 1900 bis 2000 im internationalen Vergleich ungewöhnlich erfolgreich war. Ferner schreiben sie „[i]t would be dangerous for investors to extrapolate into the future from the US experience. We need to also look outside of the United States."

Die Betrachtung des deutschen Kapitalmarktes ist nicht nur aus deutscher Sicht notwendig, sondern durchaus auch aus US-amerikanischer bzw. internationaler Sicht interessant. Mögliche Gründe hierfür sind:

- Ein wichtiger Parameter für die Anwendung des CAPMs ist die Marktrisikoprämie. Mehra/-Prescott (1985) stellen jedoch fest, dass die historische Marktrisikoprämie für den US-amerikanischen Kapitalmarkt zu hoch ist, bzw. nicht auf Basis der gängigen Modelle erklärt werden kann. Dieses Problem ist in der Literatur als „Equity Premium Puzzle" bekannt. Dimson/Marsh/Staunton (2008, S. 469) argumentieren „the historical premium may be misleading. Perhaps US equity investors simply enjoyed good fortune and the twentieth century for them represented the 'triumph of the optimists' […]." Dem fügen sie hinzu, dass „[t]his good luck story may also be accentuated by country selection bias, making the historical data even more misleading." Demnach könnte das Equity Premium Puzzle von Mehra/Prescott (1985) auf den außergewöhnlichen Erfolg des US-amerikanischen Kapitalmarkts im letzten Jahrhundert zurückzuführen sein. Möglicherweise ist es sinnvoll bei der Schätzung der zukünftig zu erwartenden (internationalen) Marktrisikoprämie für den US-amerikanischen Kapitalmarkt auch andere Kapitalmärkte einzubeziehen. Dies setzt jedoch voraus, dass Renditezeitreihen in ausreichender Qualität und mit einer weit zurückreichenden Historie vorliegen. Wichtige Probleme, die in diesem Zusammenhang auftreten können, sind der Easy-Data-Bias, Survivorship-Bias und fehlende Dividenden.
- Es ist durchaus möglich, dass empirische Ergebnisse für den US-amerikanischen Kapitalmarkt auf einen Data-Snooping-Bias zurückzuführen sind. Gemäß White (2000): „[i]t is widely acknowledged by empirical researchers that data snooping is a dangerous practice to be avoided, but in fact it is endemic." In einer wichtigen Arbeit zum Zusammenhang zwischen dem Size-Effekt und dem Data-Snooping-Bias argumentieren Lo/MacKinlay (1990, S. 431) „[t]ests of financial asset pricing models may yield misleading inferences when properties of the data are used to construct the test statistics. In particular, such tests are often based on

[7] Möglicherweise war der Neue Markt für Berater und Emissionsbanken ein Erfolg.

returns to portfolios of common stock, where portfolios are constructed by sorting on some empirically motivated characteristic of the securities such as market value of equity.“ Dieser Argumentation folgend könnte der Size-Effekt ein rein zufälliges Artefakt sein, gefunden, weil eine Vielzahl von Wissenschaftlern die CRSP-Daten systematisch auf interessante Muster hin durchsucht haben (Data Mining). Zur Validierung empirischer Ergebnisse und um einen Data-Snooping-Bias auszuschließen, könnten Out-Of-Sample-Tests durchgeführt werden. Hierbei können alternative Zeiträume oder Daten anderer Länder betrachtet werden. Studien zum deutschen Kapitalmarkt könnten hier auch eine wichtige Rolle spielen.

Letztendlich stellt sich auch die Frage, inwiefern sich der deutsche Kapitalmarkt vom amerikanischen Kapitalmarkt unterscheidet. Beispielsweise wird der deutsche Kapitalmarkt oftmals als bankendominiert, der US-amerikanische hingegen als marktdominiert eingestuft. Die relative geringe Anzahl an IPOs in Deutschland (abgesehen von der hohen Anzahl an IPOs im Neuen Markt) wird unter anderem auf die Rolle der Banken in Deutschland zurückgeführt.

2 Das CAPM, Kapitalmarktdaten und Empirische Tests des CAPMs[8]

Die moderne Portefeuilletheorie wird durch die Arbeiten vom Markowitz (1952, 1959) begründet. Markowitz zeigt, dass durch die richtige Art der Diversifikation (Anlage in Wertpapiere mit geringer Korrelation bzw. nicht perfekt positiver Korrelation der Renditen) das (Gesamt-)Risiko eines Wertpapierportefeuilles, gemessen durch die Varianz σ^2 bzw. der Standardabweichung σ der Renditen, reduziert werden kann.[9] Das Modell von Markowitz geht davon aus, dass Investoren eine „Portfolio Selection“ ausschließlich auf Basis der erwarteten Portefeuillerenditen und der Standardabweichung der einperiodigen Renditen durchführen. Hierbei gilt es, auf Portefeuilleebene das Risiko bei gleichbleibender erwarteter Rendite μ zu minimieren. Darüber hinaus bildet das Markowitz-Modell die Grundlage für die Arbeiten von Sharpe (1964), Lintner (1965) und Mossin (1966) zum Capital-Asset-Pricing-Modell (CAPM, oftmals auch als Sharpe-Lintner-CAPM oder Standard-CAPM bezeichnet). Zusätzlich zu den von Markowitz getroffenen Annahmen wird hier unterstellt, dass Investoren homogene Erwartungen haben und Geld zum risikofreien Zinssatz anlegen bzw. leihen können. Sind diese Annahmen erfüllt, so sollten im Gleichgewicht alle Investoren dasselbe μ-σ-effiziente Portefeuille risikobehafteter Wertpapiere halten, das Marktportefeuille. Ferner würden die Investoren entsprechend ihrer Risikopräferenzen Geld zum risikofreien Zinssatz leihen bzw. verleihen (Two-Fund-Seperation-Theorem). Infolgedessen ergibt sich eine lineare und positive Beziehung

8 Einen guten Überblick zum CAPM und empirischen Tests des CAPMs bietet die Arbeit von Fama/French (2004).

9 Das Konzept der Diversifikation war bereits lange vor Markowitz bekannt. Beispielsweise schreibt schreibt Smith (1924, S. 18) „without diversification, the purchase of common stocks cannot be considered.“ Markowitz war es jedoch, der dieses Problem mathematisch formulierte. Einen Überblick zu den Strategien der Diversifikation vor Markowitz gibt Troschke (2011).

zwischen dem systematischen Risiko β (Beta, der Risikobeitrag eines Wertpapiers zu einem diversifizierten Portefeuille) und der erwarteten (Über-)Rendite eines Wertpapiers.

Fast parallel zur Herleitung des CAPMs wurde Anfang der 1960er Jahre in Chicago eine erste Version der CRSP-Datenbank fertiggestellt. Ziel der CRSP-Datenbank ist es, empirische Untersuchungen zum US-amerikanischen Aktienmarkt zu erleichtern. Die CRSP-Datenbank umfasste anfangs Renditedaten zu den Aktien der NYSE für den Zeitraum von Januar 1926 bis Dezember 1960. (Fisher/Lorie 1964, S. 1) Im Laufe der Jahre wurde die CRSP-Datenbank systematisch erweitert und die Qualität der Daten verbessert. Beispielsweise umfasst die CRSP-Datenbank heute neben dem NYSE (Daten ab Dezember 1925) auch die Amex (Daten ab Juli 1962) und NASDAQ (Daten seit Dezember 1972). Die CRSP-Datenbank ist bis heute eine der wichtigsten Datenbanken zum US-amerikanischen Aktienmarkt.[10] Die Herleitung des CAPMs und die fast gleichzeitige Erstellung der CRSP-Datenbank stellen aus meiner Sicht einen Glücksfall für die empirische Forschung zum US-amerikanischen Kapitalmarkt dar. Das CAPM stellt eine Beziehung zwischen der erwarteten Rendite und dem systematischen Risiko eines Wertpapiers her. Diese Beziehung kann auf Basis der CRSP-Daten empirisch getestet werden. Eine wichtige Fragestellung hierbei ist, gilt das CAPM oder genauer, hält das CAPM empirischen Tests stand? Gemäß Stehle (2007, S. 347) „[…] bildet das Sharpe-Lintner-CAPM [bis heute] i.d.R. den Ausgangspunkt für empirische Untersuchungen über die Renditebildung bei Aktien.“

Für den deutschen Kapitalmarkt existiert erst seit circa 1990 eine Datenbank im Geiste der CRSP-Datenbank, die deutsche Finanzdatenbank (DFDB).[11] Ein wichtiger Teil der DFDB ist die Karlsruher Kapitalmarktdatenbank (KKMDB), welche Daten zu deutschen Aktien bereitstellt. Allerdings werden die Daten der DFDB in letzter Zeit nur selten verwendet, insbesondere internationale Studien zum europäischen Kapitalmarkt verwenden für Deutschland Daten von Thomson Reuters Datastream (Datastream) anstatt der DFDB. Die wichtigsten Datenquellen für den deutschen Kapitalmarkt sind aus meiner Sicht: die deutsche Finanzdatenbank (DFDB)[12], Datastream, Worldscope Financial Database und Bloomberg. Neben diesen Datenquellen gibt es auch aufbereitete Datensätze (Portefeuilledaten) für den deutschen Kapitalmarkt. Beispielsweise stellt Kenneth R. French in seiner Data Library Portefeuilledaten für den US-amerikanischen und verschiedene internationale Kapitalmärkte (einschließlich Deutschland) zur Verfügung. Kürzlich wurde vom Centre for Financial Research (CFR) in Köln ein ähnlicher Datensatz für den deutschen Kapitalmarkt eingeführt. Eine genaue Beschreibung der Daten ist in Artmann et al. (2012b) enthalten. Einen Überblick zu weiteren Datensätzen und historischen Zeitreihen für den deutschen Aktienmarkt gibt Ehrhardt (2012).

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[10] Eine weitere wichtige Datenbank zum US-amerikanischen Markt ist die 1962 eingeführte COMPUSTAT-Bilanzdatenbank.

[11] 1988 wurde in Deutschland bei der Deutschen Forschungsgemeinschaft der Schwerpunktbereich Empirische Kapitalmarktforschung beantragt. Infolgedessen wurde im Jahr 1989 offiziell mit dem Aufbau der deutschen Finanzdatenbank begonnen. Die ersten Ergebnisse dieser Bemühungen wurden 1993 im Sonderheft 31 Empirische Kapitalmarktforschung, Zeitschrift für betriebswirtschaftliche Forschung (zfbf) publiziert.

[12] Die deutsche Finanzdatenbank wird von Bühler et al. (1993) beschrieben. Teil dieser Datenbank ist die Karlsruher Kapitalmarktdatenbank (KKMDB) und die Jahresabschlussdatenbank an der RWTH Aachen.

Für robuste und valide empirische Ergebnisse ist eine hohe Datenqualität essenziell. Dimson/March/-Staunton (2002, S. 4) schreiben „[g]ood data is the key to understanding history." Rosenberg/Houglet (1974, S. 1303) argumentieren, dass „[t]he presence of erroneous data can destroy a research effort and seriously damage the management decisions based upon research." Die Qualität der CRSP-Daten wurde bereits ausführlich untersucht und kontinuierlich verbessert. Zur Qualität der oben genannten Datenquellen zum deutschen Kapitalmarkt ist hingegen bisher wenig bekannt. Zudem gibt es Hinweise darauf, dass die Qualität der von den oben genannten Quellen bereitgestellten Daten zum Teil nicht ausreichend ist.[13] So sollte Datastream aufgrund von systematischen Fehlern nicht als primäre Datenquelle vor 1990 verwendet werden. Die Qualität des vom CFR bereitgestellten Datensatzes wird durch einen Survivorship-Bias beeinträchtigt. Hinzu kommt, dass die Daten für Deutschland zumeist nur für den Zeitraum ab 1960 (KKMDB, zumindest für 100 Aktien, für alle Aktien ab 1974) bzw. 1973 (Datastream) verfügbar sind. Unser Datensatz für den deutschen Kapitalmarkt umfasst hingegen den Zeitraum ab 1948. Die Qualität dieser Daten wurde mehrfach überprüft und die Daten bereits in mehreren Studien, wie zum Beispiel von Dimson/Marsh/Staunton (2002, 2008), Schrimpf et al. (2007) und Ziegler et al. (2007) verwendet.

Die ersten empirischen Tests des CAPMs wurden von Lintner (1965) und Douglas (1969) durchgeführt. Miller/Scholes (1972) fassen einige der Probleme dieser frühen Tests, wie zum Beispiel die Auswirkung von Beta-Messfehlern auf die Regressionsergebenisse, zusammen. Die ersten ausführlichen Tests werden von Black/Jensen/Scholes (1972) und Fama/MacBeth (1973) durchgeführt. Diesen beiden Studien kommt eine besondere Bedeutung zu, da sie Testverfahren vorstellen, die noch heute zu den Standardverfahren im Bereich der Empirischen Kapitalmarktforschung gehören. Die Studien von Black/Jensen/Scholes (1972) und Fama/MacBeth (1973) bestätigen für den Zeitraum von 1926 bis 1966 bzw. 1935 bis 1968 eine positive Beziehung zwischen der durchschnittlichen Rendite und dem systematischen Risiko der untersuchten Wertpapiere. Allerdings ist der Anstieg der empirischen im Vergleich zur theoretischen Wertpapiermarktlinie etwas zu flach und der Schnittpunkt der Wertpapiermarktlinie etwas höher als der risikofreie Zinssatz. Dieses Ergebnis widerspricht dem CAPM, steht aber prinzipiell im Einklang mit dem Modell von Black (1972), dem Zero-Beta-CAPM. Spätere Arbeiten wie beispielsweise Fama/French (1992) zeigen für den Zeitraum von 1962 bis 1990, dass die Beziehung zwischen den durchschnittlichen Aktienrenditen und Beta flach oder sogar negativ ist. Hinzu kommt, dass Faktoren wie Size und Buchwert-/Marktwertverhältnis die Aktienrenditen erklären können. Beide Beobachtungen sind nicht mit dem CAPM vereinbar.

Die Ergebnisse von Black/Jensen/Scholes (1972) und Fama/MacBeth (1973) können mit denen von Fama/French (1992) allerdings nicht direkt verglichen werden, da sich die Untersuchungszeiträume unterscheiden. Die Ursache hierfür ist, dass Fama/French (1992) vor 1962 keine Buchwerte des Eigen-

[13] Stehle (2007, S. 349) schreibt beispielsweise „Bei den führenden kommerziell angebotenen Datenbanken ist die erforderliche Qualität heute sicherlich für die Datenjahre ab 1995 vorhanden (vgl. Ince/Porter 2007). Über die Jahre zuvor sind Aussagen schwierig." Hier leistet der dritte Aufsatz dieser Dissertation einen wichtigen Beitrag.

kapitals zur Verfügung standen, „[t]he 1962 start date reflects the fact that book value of common equity (COMPUSTAT item 60), is not generally available prior to 1962.“ (Vgl. Fama/French 1992, S. 429) Dies zeigt, dass empirische Studien ohne geeignete Daten (hochwertige Daten in ausreichender Qualität für einen langen Zeitraum) nicht durchgeführt werden können. Spätere Untersuchungen wie beispielsweise von Ang/Chen (2007) bestätigen die Ergebnisse von Black/Jensen/Scholes (1972) und Fama/MacBeth (1973) für den Zeitraum vor 1963. Ang/Chen (2007) zeigen, dass das CAPM durchaus in der Periode von 1926 bis 1963 gilt. Fama/French (2006) zeigen zwar, dass die Ergebnisse von Ang/Chen (2007) korrekt sind, allerdings zeigen Fama/French (2006, S. 2184) auch, dass „variation in β unrelated to size and B/M goes unrewarded during 1928 to 1963.” Demnach gibt es für den Zeitraum vor 1963 durchaus widersprüchliche Ergebnisse zur Gültigkeit des CAPMs. Für den Zeitraum nach 1963 lehnen die meisten empirischen Studien das CAPM ab.

Aufgrund der Vielzahl von empirischen Ergebnissen zum CAPM, die zeigen, dass das Beta die Renditen von Wertpapieren nicht bzw. nicht allein erklären kann, dominiert derzeit die Meinung, dass das CAPM, insbesondere in den USA, nicht gilt. Wie in der obigen Diskussion angedeutet, sind Eugene F. Fama und Kenneth R. French prominente Vertreter dieser Meinung. Die Aussagen stützen sich oftmals auf Anomalien, wie z. B.: dem Size-, Buchwert-/Marktwert- und Momentum-Effekt und/oder der empirischen Beobachtung, dass die Beziehung zwischen dem systematischen Risiko und der (tatsächlichen) ex post Rendite nicht wie vom CAPM prognostiziert positiv und linear ist. Oftmals wird zur Verdeutlichung der Ergebnisse auch vor einer dramatischen Wortwahl nicht zurückgeschreckt. So schreiben Fama/French (1992, S. 438) „In a shot straight at the heart of the SLB model [CAPM], the average slope from the regressions of returns on β alone […] is 0.15% per month and only 0.46 standard errors from 0. In the regressions of returns on size and β, size has explanatory power (an average slope -3.41 standard errors from 0), but the average slope for β is negative and only 1.21 standard errors from 0.” Untersuchungen zum deutschen Kapitalmarkt kommen zu ähnlichen Ergebnissen, bspw. schreiben Artmann et al. (2012a, S. 8) „Beta remains dead“.

3 Probleme der Testverfahren

Bei der Interpretation empirischer Ergebnisse werden wichtige Probleme der empirischen Testverfahren oft nicht oder nur unzureichend berücksichtigt. Roll (1977, S. 129) schreibt in einem viel beachteten Aufsatz „Testing the two-parameter asset pricing theory is difficult (and currently infeasible). Due to a mathematical equivalence between the individual return/‘beta’ linearity relation and the market portfolio’s mean-variance efficiency, any valid test presupposes complete knowledge of the true market portfolio’s composition. This implies, inter alia, that every individual asset must be included in a correct test.” Diese Kritik, welche als “Roll’s Critique” bekannt ist, wird auch in den Standardlehrbüchern wie z. B. Bodie/Kane/Marcus (2011, S. 325-326) aufgegriffen. Nach Roll können die Implikationen des CAPM, wie zum Beispiel die positive und lineare Beziehung zwischen Beta und

Rendite, nicht getestet werden, es sei denn die Zusammensetzung des wahren Marktportefeuilles ist bekannt. Da das wahre Marktportefeuille nicht bekannt ist, kann lediglich getestet werden, ob der Proxy für das Marktportefeuille μ-σ-effizient ist. Darüber hinaus wird oftmals argumentiert, dass das CAPM eine Aussage zur ex ante erwarteten Rendite und nicht der tatsächlichen ex post Rendite, welche zwar Erwartungen widerspiegeln, zugleich jedoch „noise" beinhaltet, trifft. Aus diesem Grund werden gewöhnlicherweise lange Renditezeitreihen zum Testen des CAPMs herangezogen. (Brealey/-Myers/Allen 2011, S. 226) Ferner ist das „wahre" Beta eines Wertpapiers nicht beobachtbar und kann ebenfalls nur geschätzt werden.

In einem kürzlich erschienenen Aufsatz zeigen Levy/Roll (2010, S. 2464), dass „slight variations in parameters [Änderung von μ und σ der Testassets], well within estimation error bounds, suffice to make the proxy efficient. Thus, many conventional market proxies could be perfectly consistent with the CAPM and useful for estimating expected returns." Diese Beobachtung ist wichtig, da wie oben angedeutet das CAPM nur gilt, wenn der Proxy für das Marktportefeuille μ-σ-effizient ist. Das gängigste Verfahren zum Test dieser Hypothese (das Marktportefeuille ist effizient) ist der multivariate Test von Gibbons/Ross/Shanken (1989). Affleck-Graves/McDonald (1989) zeigen jedoch, dass aufgrund von nicht-normalverteilten Residuen die Aussagekraft des statistischen Tests nach Gibbons/-Ross/Shanken (1989, GRS) überschätzt und die Ausprägung der p-Werte für die GRS-Teststatistik unterschätzt wird. Somit wird die Nullhypothese, dass das CAPM gilt, zu oft abgelehnt. Hinzu kommt, das die Aussagekraft des Tests von der Anzahl der Test-Assets abhängt. Grauer/Janmaat (2009, S. 780) kommt zu dem Ergebnis, dass der empirische Test nach Fama/MacBeth (1973) eine geringe Aussagekraft hat. Die Nullhypothese, dass der Regressionskoeffizient für Beta gleich null ist, kann demnach unter Umständen mit dem Fama/MacBeth-Test irrtümlicherweise nicht abgelehnt werden (Fehler 2. Art). Das Hauptargument hierbei ist, das gängige Portefeuillesortierungen, wie zum Beispiel nach Size und Buchwert-/Marktwertverhältnis, nicht zu einer ausreichenden Spannweite der Portefeuillebetas führen, was wiederum die statistische Aussagekraft des Testverfahrens reduziert. Grauer/Janmaat (2009) führen ein interessantes Verfahren ein, um die Aussagekraft des Tests zu erhöhen.

Aus unserer Sicht existiert bis dato keine international anerkannte „optimale" Vorgehensweise zum Test des CAPMs. Die derzeit wichtigsten Testverfahren basieren auf den Arbeiten von Black/Jensen/-Scholes (1972), Fama/MacBeth (1972) und Gibbons/Ross/Shanken (1989). Bei der Anwendung dieser Testverfahren gibt es eine Reihe von Freiheitsgraden. So können bspw. gleich- oder marktwertgewichtete Renditen, monatliche, vierteljährliche oder jährliche Renditen, einzelne Unternehmen oder Portefeuilles, ein-, zwei- oder dreidimensional sortierte Portefeuilles, etc. betrachtet werden. Letztendlich können wir nicht sagen, welches Testverfahren bzw. welche Variation eines Testverfahrens optimal ist. Allerdings können die Probleme der einzelnen Variationen bei der Anwendung der Testverfahren diskutiert und somit nicht-optimale Vorgehensweisen bzw. Variationen aufgezeigt werden. Beispielsweise werden aus unserer Sicht empirische Ergebnisse auf Basis individueller Beobachtungen, nach Size sortierter Portefeuilles oder gleichgewichteter Portefeuilles zu stark von den vielen kleinen Unternehmen beeinflusst. Kleine Unternehmen werden nur selten gehandelt, weisen eine geringe Liquidität auf und eine relativ hohe serielle Autokorrelation der Renditen. Infolgedessen werden nach Scholes/Williams (1977) und Dimson (1979) die OLS-Betas für diese Unternehmen asymptotisch unterschätzt. Hierdurch werden empirischer Ergebnisse für kleine Unternehmen in ihrer Aussagekraft beeinträchtigt.

4 Der Geregelte Markt in Frankfurt: Ein ökonomischer Nachruf

Die meisten empirischen Untersuchungen zum deutschen Aktienmarkt konzentrieren sich auf das höchste deutsche Marktsegment, dem Amtlichen Markt in Frankfurt. Dementsprechend gibt es für den Amtlichen Markt im Vergleich zum Geregelten Markt eine relativ hohe Anzahl von empirischen Untersuchungen, unter anderem zur kurz- und langfristigen IPO-Performance, Dividendenpolitik der Unternehmen, dem Size-Effekt und der langfristigen Performance der Unternehmen in diesem Segment. Einige Studien beziehen die Aktien des Geregelten Marktes ein, unterscheiden jedoch nicht explizit zwischen den verschiedenen Marktsegmenten. Implizit wird dabei unterstellt, dass in Deutschland kein Marktmikrostruktureffekt wie in den USA existiert.[14] Zu den wenigen Studien, die empirische Untersuchungen zum Geregelten Markt durchführen zählen unter anderem Schmidt/-Schrader (1993), Rasch (1994) und Neuhaus/Schrember (2003).

Wichtige Fragestellungen, die für den Geregelten Markt bisher unbeantwortet blieben bzw. nur zum Teil beantwortet werden, sind:

- War die institutionelle Ausgestaltung des Geregelten Marktes ausreichend um einen Erfolg dieses Segments zu gewährleisten, oder stellte der Geregelte Markt ein ähnliches Desaster wie der Neue Markt dar?
- Wie viele Unternehmen gingen im Rahmen eines IPOs im Geregelten Markt an die Börse?
- Konnten die Unternehmen im Rahmen von Kapitalerhöhungen weiteres Eigenkapital aufnehmen?
- Wie viele Unternehmen wechselten aus dem Geregelten Markt in den Amtlichen Markt?
- Wie viele Unternehmen verließen dieses Segment und aus welchen Gründen?
- Konnte die durchschnittliche risikoadjustierte Rendite der Unternehmen des Geregelten Marktes in Frankfurt mit der des Amtlichen Marktes mithalten?

Das Ziel des ersten Aufsatzes ist es, derartige Fragestellungen zu beantworten. Hierzu erstellten wir eine spezielle Datenbank für den Geregelten Markt in Frankfurt. Diese Datenbank ist aus unserer Sicht

[14] Der Marktmikrostruktureffekt in den USA wird von Reinganum (1990) und Loughran (1993) dokumentiert.

eine in Deutschland einzigartige Datenbank zum Geregelten Markt in Frankfurt. Die beiden wichtigsten Ergebnisse sind:

- Trotz des „Aderlasses“ durch Aufsteiger in den Amtlichen Markt (im Schnitt 2,34 % der zum Jahresanfang notierten Aktien zwischen 1990 und 2007) konnte anders als im Amtlichen Markt eine fast stetige Zunahme der Zahl der notierten inländischen Aktien verzeichnet werden.
- Bei Zugrundelegung des CAPMs ergibt sich, dass die Aktien des Geregelten Marktes im Schnitt etwas besser abschnitten, als die Aktien des Amtlichen Marktes. Dieses Ergebnis ist allerdings sensitiv im Hinblick auf die Vorgehensweise.

Zusammenfassend war der Geregelte Markt, insbesondere im Vergleich zum Neuen Markt, ein voller Erfolg für alle Marktteilnehmer. Diese Tatsache war bisher wahrscheinlich nicht klar, sonst wäre der Geregelte Markt in Frankfurt vielleicht nicht im Rahmen der Harmonisierung der EU-Kapitalmärkte Anfang November 2007 eingestellt worden. Seitdem werden die meisten Aktien des ehemaligen Geregelten Marktes im Regulierten Markt notiert.

5 In Germany the CAPM is Alive and Well

Die bisherigen Untersuchungen zur Gültigkeit des CAPMs für den deutschen Kapitalmarkt unterscheiden sich oftmals erheblich in ihrer Vorgehensweise und ihren Ergebnissen.[15] Beispielsweise kommen Ziegler et al. (2007) zu dem Ergebnis, dass sowohl Size- als auch Buchwert-/Marktwert-Faktoren eine wichtige Rolle zur Erklärung deutscher Aktienrenditen zukommt. Artmann et al. (2012a) hingegen stellen fest, dass Size deutsche Aktienrenditen nicht erklären kann. In ihrer Zusammenfassung schreiben sie „[…] we find that the value and the momentum factors are the main drivers of stock returns.“ Überraschenderweise fassen Artmann et al. (2012b, S. 41) ihre Ergebnisse wie folgt zusammen „[w]e do not find evidence of a book-to-market or a size effect.“ Unklar ist jedoch die genaue Ursache für die unterschiedlichen Ergebnisse. Beispielsweise betrachten die Studien von Artmann et al. (2012a und 2012b) und Ziegler et al. (2007) unterschiedliche Zeiträume und verwenden unterschiedliche Datensätze. Der Datensatz von Artmann et al. (2012a und 2012b) umfasst neben dem Amtlichen Markt in Frankfurt auch den Neuen Markt und zum Teil den Geregelten Markt in Frankfurt. Der Datensatz von Ziegler et al. (2007) umfasst hingegen nur den Amtlichen Markt in Frankfurt. Völlig unklar bleibt, warum Artmann et al. (2012a) zu einem anderen Ergebnis hinsichtlich des Value-Effektes kommt als Artmann et al. (2012b), insbesondere da keine der beide Studien auf diesen Widerspruch eingeht.

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15 Einen Überblick zu den Ergebnissen verschiedener Studien zum deutschen Aktienmarkt geben unter anderem Artmann et al. (2012a und 2012b), Stehle (2007) und Schulz/Stehle (2002).

Das Ziel des zweiten Aufsatzes ist es unter anderm, die bisherigen empirischen Ergebnisse für den deutschen Kapitalmarkt zu prüfen. In unseren Untersuchungen verwenden wir die oben genannten Testverfahren von Black/Jensen/Scholes (1972), Fama/MacBeth (1973) und Gibbons/Ross/Shanken (1989). Diese Verfahren betrachten wir als ideale Komplemente zueinander. Zusätzlich gehen wir auf deutsche Besonderheiten (Stamm- vs. Vorzugsaktie, Körperschaftsteuergutschrift, vertikale und horizontale Marktsegmentierung) ein und diskutieren, inwiefern diese empirische Ergebnisse beeinflussen. Gleichzeitig wollen wir auf Probleme aufmerksam machen, die bisher nicht thematisiert wurden. Beispielsweise diskutieren wir die Zusammensetzung des Marktportefeuilles für den deutschen Kapitalmarkt. In den empirischen Untersuchungen konzentrieren wir uns auf die Unternehmenscharakteristika Size und Buchwert-/Marktwertverhältnis. Wir führen eine „Battery of Tests" durch und erhalten so eine Vielzahl interessanter Ergebnisse:

- Die empirischen Ergebnisse variieren unter anderem mit der Portefeuillebildung, der Gewichtung der einzelnen Unternehmen, dem betrachteten Zeitraum, der Betaschätzung (OLS- vs. Dimson-Beta) und dem Renditeintervall (monatlich, vierteljährlich oder jährlich).
- Die Gewichtung der einzelnen Aktienrenditen bei der Portefeuillebildung spielt eine wichtige Rolle, wenn wir nicht nach der Marktkapitalisierung sortieren.
- Die Verwendung von Full-Period-Betas auf Basis jährlicher Renditeintervalle anstatt auf Basis monatlicher Dimson-Betas verbessert die Performance des CAPMs wesentlich.

Die wichtigsten Ergebnisse lassen sich wie folgt zusammenfassen:

- Sowohl der Size- als auch der Buchwert-/Marktwert-Effekt spielen in Deutschland eine wichtige Rolle. Allerdings sind beide Effekte im Zeitablauf nicht stabil.
- Einer Erweiterung des CAPMs um Size- und/oder Buchwert-/Marktwertfaktoren erscheint aufgrund unserer empirischen Ergebnisse derzeit nicht sinnvoll.

Insgesamt schlussfolgern wir, dass auf Basis unserer Ergebnisse das CAPM in Deutschland nicht abgelehnt werden kann. Dieses Ergebnis stellt die vorherrschende Meinung, wonach das CAPM nicht gilt, zumindest für Deutschland infrage. Aus unserer Sicht kann das CAPM in Deutschland weiterhin wie bisher in seiner Standardform verwendet werden.

6 Important Characteristics, Weaknesses and Errors in German Equity Data from Thomson Reuters Datastream and their Implications for Empirical Studies on Stock Returns

Im dritten Aufsatz wird unter anderem die Qualität der von Datastream für den deutschen Kapitalmarkt bereitgestellten Daten untersucht. Indirekt wird durch diese Arbeit auch die Qualität der eigenen

Datenbank zum deutschen Aktienmarkt dokumentiert.[16] Datastream ist neben Bloomberg eine der wichtigsten Datenbanken für die weltweite empirische Kapitalmarktforschung.[17] In den letzten Jahren verwendet eine stetig steigende Anzahl von internationalen aber auch deutschen Studien Datastream-Daten. Ince/Porter (2006, S. 463) weisen jedoch darauf hin, dass die Datastream-Daten nicht fehlerfrei sind und „naive use of TDS [Datastream] data can have a large impact on economic inferences". Ince/Porte (2006) zeigen allerdings auch, dass sich die Auswirkungen der Datastream-Fehler auf empirische Ergebnisse mit Hilfe von verschiedenen Screening-Prozeduren begrenzen lassen.

Unklar ist bisher jedoch, wie gut die von Datastream bereitgestellten Daten für den deutschen Kapitalmarkt tatsächlich sind, bzw. inwiefern die Daten für empirische Untersuchungen geeignet sind. Unklar ist auch, welche Arten von Fehlern in den Datastream-Daten vorkommen. Ein wesentlicher Beitrag des dritten Aufsatzes ist es, die Qualität der Datastream-Daten außerhalb der USA systematisch zu untersuchen. Hierbei komme ich zu dem Ergebnis, dass Datastream als primäre Datenquelle für den deutschen Kapitalmarkt vor 1990 ungeeignet ist. Dies begründet sich hauptsächlich durch Probleme bei der Marktabdeckung, es fehlen einige Aktien und es gibt zusätzlich einen Survivorship-Bias. Ferner gibt es Probleme bei der Einbeziehung von Dividenden vor 1990, die Dividendenzeitreihe ist unvollständig und der Total-Return-Index wird in der Regel nicht richtig um Dividendenzahlungen bereinigt. Nach 1990 kommt es zwar zu zufälligen Fehlern in Datastream, allerdings sind diese nur selten gravierend.

Zusätzlich zeige ich im dritten Aufsatz, dass die Verwendung von Datastream-Daten durchaus auch nach 1990 problematisch sein kann. Dies hängt damit zusammen, dass Datastream nicht zwischen den einzelnen Marktsegmenten an den deutschen Börsen unterscheidet. Eine Portefeuillebildung auf Basis von Breakpoints für das höchste Marktsegment ist somit nicht möglich. In den USA werden traditionell NYSE-Breakpoints (das Top-Marktsegment) verwendet, um die kleinen Aktien der Amex und NASDAQ den NYSE-Portefeuilles zuzuordnen. Fama/French (2011, S. 6) schreiben hierzu „[i]n our previous work on US stocks (e.g. Fama and French, 1993) we use NYSE breakpoints for size and B/M, to avoid sorts that are dominated by the plentiful but less important tiny Amex and NASDAQ stocks."[18] Diese Vorgehensweise könnte in Deutschland prinzipiell repliziert werden. Analog zum US-amerikanischen Markt könnten Breakpoints für den Amtlichen Markt in Frankfurt, dem höchsten Börsensegment in Deutschland, zur Portefeuillebildung verwendet werden. Allerdings ist diese

[16] Für den Geregelten Markt in Frankfurt wurden für 496 Aktien (inkl. Neuer Markt) alle relevanten Daten wie zum Beispiel Aktienkurse, Dividenden, Kapitalmaßnahmen, Anzahl der Aktien, etc. eigenständig zusammengetragen. Für den Amtlichen Markt in Frankfurt wurde die bereits bestehende Stehle-Datenbank für den Zeitraum 1996 bis 2007 erweitert. Hierbei wurden Daten für 544 Aktien erhoben. Die Daten wurden unter anderem den Hoppenstedt Aktienführen und Kurstabellen, den Saling Aktienführern, der Karlsruher Kapitalmarktdatenbank, dem Xetra Newsboard, der Börsenzeitung und vielen anderen Quellen entnommen. Die Erstellung der Datenbanken wurde sehr sorgfältig durchgeführt. Insgesamt dauerte die Datenerhebung inkl. nachträglicher Korrekturarbeiten ca. 2 bis 3 Jahre. Ferner wurde die Datenbank zum Amtlichen Markt für die Jahre 1988 bis 1996 qualitativ verbessert.

[17] In der Forschung zum US-amerikanischen Aktienmarkt spielt Datastream aufgrund der Dominanz der CRSP-Daten nur eine geringe Rolle.

[18] Indirekt bestätigen Fama/French (2011) mit dieser Aussage unsere Vermutung, dass die kleinen Aktien einen zu starken Einfluss auf die Ergebnisse von Fama/French (1992) haben.

Vorgehensweise auf Basis der Datastream-Daten derzeit nicht umsetzbar. Unklar ist bisher, ob und wie sich dies auf empirische Ergebnisse zum deutschen Aktienmarkt auswirkt.

In unserem gemeinsamen Aufsatz mit Patrick Lehmann und Richard Stehle zum CAPM in Deutschland berücksichtigen wir die vertikale Marktsegmentierung und dokumentieren für Deutschland im Zeitraum von Juli 1990 bis Oktober 2007 einen statistisch und ökonomisch signifikanten Reverse-Size-Effekt. Unter Verwendung von Datastream-Daten ist dieser Effekt auf Basis der üblichen Vorgehensweise (Bildung von 10 Size-Decile-Portefeuilles, wobei jedem Portefeuille die gleiche Anzahl von Aktien zugeteilt wird) nicht nachweisbar. Erst wenn Size-Breakpoints für den Amtlichen Markt in Frankfurt zur Portefeuillebildung verwendet werden, kann ein Reverse-Size-Effekt festgestellt werden. Demnach hat die Portefeuillebildung neben den oben genannten Einflussfaktoren (vgl. Abschnitt 1.5) einen erheblichen Einfluss auf empirische Ergebnisse zum deutschen Kapitalmarkt. Diese Beobachtung ergänzt in idealerweise die Argumentationslinie unseres Aufsatzes zum CAPM. Eine der impliziten Kernaussagen dieses Aufsatzes ist, dass bei der Durchführung empirischer Tests länderspezifische Gegebenheiten, insbesondere in Hinblick auf die verwendeten Daten, stärker zu berücksichtigen sind. Leider ist es oftmals so, dass „blind“ eine für die USA hergeleitete Vorgehensweise übernommen wird, ohne zu prüfen, inwiefern diese auf den zu betrachtenden Kapitalmarkt angewendet werden kann. Wünschenswert wäre hier eine kritischere Auseinandersetzung mit den empirischen Methoden.

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PART II

Der Geregelte Markt in Frankfurt: Ein ökonomischer Nachruf

Inhalt

Der Geregelte Markt in Frankfurt: Ein ökonomischer Nachruf

Zusammen mit Richard Stehle*

Abstract

Der Geregelte Markt war zwischen 1987 und 2007 das zweithöchste deutsche Börsensegment. Kennzeichnend für den Geregelten Markt sind eine im Vergleich zum Amtlichen Markt geringe Anzahl gehandelter Aktien, ein sehr geringes Handelsvolumen und eine ebenfalls sehr geringe durchschnittliche Marktkapitalisierung. Darüber hinaus ist, abgesehen von den institutionellen Aspekten, bisher nur wenig über die ökonomischen Aspekte des Geregelten Marktes bekannt. Unklar ist unter anderem, ob der Geregelte Markt ein Erfolg oder Misserfolg, so wie zum Beispiel der Neue Markt, war. Auf Basis einer speziell für den Geregelten Markt in Frankfurt erstellten Datenbank kommen wir zu einer Vielzahl interessanter Ergebnisse. Beispielsweise wurde der Amtliche Markt in Frankfurt im Hinblick auf die Zahl der Börseneinführungen (in Prozent der jeweils notierten Gesellschaften) übertroffen. Eine Vielzahl von Unternehmen nutzte den Geregelten Markt als Einstiegssegment und wechselte später in den Amtlichen Markt. Bei Zugrundelegung des Sharpe-Lintner-Modells kann sich die risikoadjustierte Durchschnittsrendite der Unternehmen des Geregelten Marktes mit der des Amtlichen Marktes in Frankfurt durchaus messen.

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1 Einleitung

In vielen Industrieländern verteilt sich der Aktienhandel traditionell auf zwei bis drei vertikale Marktsegmente pro Börse und/oder auf mehrere Börsen, die sich auf bestimmte Werte konzentrieren. Üblicherweise sind die Zulassungsvoraussetzungen und Folgepflichten der unteren Marktsegmente niedriger. Ziel dieser Segmentierung ist es insbesondere, kleinen und mittleren Unternehmen den Zugang zum Kapitalmarkt zu erleichtern. In den 80er Jahren wurden an einigen europäischen Börsen neue Marktsegmente („Second Markets") wie beispielsweise der Second Marché in Frankreich und der Geregelte Markt in Deutschland eingeführt. Mitte der 90er Jahre kamen die „Neuen Märkte" („New Markets") wie zum Beispiel der Nouveau Marché in Frankreich, der Nuovo Mercato in Italien und der Neue Markt in Deutschland hinzu. Neben diesen Marktsegmenten existierten in einigen Ländern bereits seit Längerem verschiedene Freiverkehrssegmente wie der Marché Libre in Frankreich, der Mercato Ristretto in Italien und der Freiverkehr in Deutschland. In den USA existierte neben dem New York Stock Exchange (NYSE) unter anderem der American Stock Exchange (AMEX) und seit 1971 das NASDAQ-System. Bis Mitte der achtziger Jahre wurden an der NYSE nur etablierte Aktien gehandelt, IPOs fanden nur an anderen US-amerikanische Börsen statt.

In Deutschland existierten ab 1912 mehrere Börsenplätze, an denen jeweils ein Amtlicher Handel entsprechend dem Börsengesetz von 1896 stattfand und ein der lokalen Börsenordnung unterliegender Freiverkehr. Im Laufe der Zeit wurde zwischen dem Geregelten Freiverkehr und dem Ungeregelten Freiverkehr differenziert. 1987 wurde der Geregelte Freiverkehr durch den Geregelten Markt[1] ersetzt und aus dem Ungeregelten Freiverkehr wurde der Freiverkehr. Zwischen 1997 und 2003 existierte an der Frankfurter Börse zusätzlich der Neue Markt und von 1999 bis 2003 der Small Cap Exchange (SMAX).[2] 2007 wurden der inzwischen in Amtlicher Markt umbenannte Amtliche Handel und der Geregelte Markt zum Regulierten Markt vereinigt.[3] Seit 2003 differenziert die Deutsche Börse AG, der Betreiber der Frankfurter Börse, innerhalb der beiden oberen Segmente (dem jetzigen Regulierten Markt) zwischen dem General Standard und dem Prime Standard. Der Freiverkehr wurde 2005 in Open Market umbenannt und innerhalb des Open Markets das Prädikatssegment Entry Standard geschaffen. In Anbetracht der kurzen Zeit zwischen diesen erheblichen Eingriffen in die deutsche Börsenstruktur stellt sich die Frage, welche Vorteile brachten diese Restrukturierungen?

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[1] In der älteren Literatur, insbesondere in der Finanzpresse und in Publikationen, die vor 2000 erschienen, wird häufig die Schreibweise geregelter Markt verwendet, wir bevorzugen wie viele neuere Beiträge die Großschreibung, also Geregelter Markt. Ein Grund hierfür ist, dass der englischsprachige Begriff „regulated market" häufig mit geregelter Markt übersetzt wird. Durch die Großschreibung wird verdeutlicht, dass auf das deutsche Börsensegment Bezug genommen wird. Die Kleinschreibweise wird z. B. von *Hiding* (1987); *Stedler* (1987); *Schrader* (1993) verwendet, die Großschreibung von *Rasch* (1994); *Hopt/Baum* (1997).

[2] Details zum Neuen Markt geben u. a. *Ballwieser* (2001); *Gerke/Fleischer* (2001); *Kiss/Stehle* (2002); *Hunger* (2003). Mit dem SMAX setzen sich u. a. *Gassen/Kaltofen* (2005) auseinander.

[3] Der Amtliche Handel wurde zum 1. Januar 2003 in Amtlicher Markt umbenannt, wir verwenden im Folgenden durchgehend die Bezeichnung Amtlicher Markt.

Der vorliegende Beitrag konzentriert sich auf den wissenschaftlich bisher wenig diskutierten ökonomischen Erfolg des Geregelten Marktes, wobei insbesondere die gesamtwirtschaftliche Sichtweise sowie die Sichtweisen von Anlegern und notierten Unternehmen und nicht die Perspektiven des Betreibers, der im Aktienhandel und im Emissionsgeschäft tätigen Banken gewählt werden. Wichtige Fragestellungen in diesem Kontext sind:

- Wurde der Zugang zur Börse wie erhofft in adäquater Weise (also auch nicht zu stark) erleichtert?
- Fanden Unternehmen bei der Erstemission und bei weiteren Emissionen einen guten Zugang zu weiterem Kapital?
- Waren die Eigenkapitalkosten der Unternehmen bzw. die Renditen der Aktionäre risikoadäquat?

Derartige Fragestellungen wurden in den USA für den NYSE, den AMEX und das NASDAQ-System bereits intensiv diskutiert.[4] Der Geregelte Markt existierte über 20 Jahre, im Prinzip sollten also ausreichend Daten vorliegen, um diese Fragen zu beantworten. Allerdings existiert keine speziell auf den Geregelten Markt zugeschnittene Datenbank, die eine Beantwortung der genannten Fragen erleichtert. Auch wurde für den Geregelten Markt kein eigener Aktienindex berechnet. Die dort notierten Aktien waren zwar ab 1998 im CDAX enthalten,[5] für dessen Wertentwicklung spielten sie jedoch nur eine geringe Rolle. Dies hat möglicherweise dazu beigetragen, dass nur wenige empirische Arbeiten zum Geregelten Markt existieren. Hervorzuheben sind die Arbeiten von *Schmidt/Schrader* (1993) zu den Kurseffekten beim Wechsel vom Geregelten Freiverkehr in den Geregelten Markt und von *Rasch* (1994), in der insbesondere auf die geringe Umsatztätigkeit und dem niedrigen Streubesitzanteil hingewiesen wird . Einige Arbeiten zur Zeichnungsrendite bei Börseneinführungen wie zum Beispiel *Stehle-/Erhardt* (1999) und *Hunger* (2003) differenzieren zwischen den jeweils existierenden Marktsegmenten. Viele Arbeiten beziehen die Aktien des Geregelten Marktes zwar ein, versäumen es jedoch in Bezug auf die Segmentzugehörigkeit zu differenzieren.

In Anbetracht der vorhandenen Literatur gehen wir nur kurz auf die institutionellen Rahmenbedingungen ein und stellen vorrangig die bisher weniger berücksichtigten ökonomischen Aspekte des Geregelten Marktes dar. Ziel dieser Arbeit ist es, zum besseren Verständnis der vertikalen Börsensegmentierung in Deutschland beizutragen. Möglicherweise erleichtert eine solche Börsensegmentierung kleinen und mittleren Unternehmen den Zugang zur Börse und führt für bereits notierte Unternehmen zu einer Verbesserung der Eigenkapitalausstattung. Als Folge ergeben sich möglicherweise eine bessere Allokation der Ressourcen und ein besseres Wirtschaftswachstum.

Unsere Untersuchungen zum Geregelten Markt erstrecken sich ausschließlich auf den Geregelten Markt in Frankfurt (im Folgenden als Geregelter Markt bezeichnet). Zum einem ist Frankfurt der wichtigste Börsenplatz in Deutschland (im Juli 1988 wurden 71,5 %, im Juli 1997

[4] Vgl. z. B. *Reinganum* (1990) und *Loughran* (1993).
[5] Vgl. ohne Verfasser (1998), S. 26.

77,8 % und im Juli 2007 88,4 % der gesamten Wertpapierumsätze in Deutschland an der Börse Frankfurt getätigt)[6], zum anderen wäre eine Vollerhebung aller Aktien, die in deutschen Geregelten Märkten notiert waren, zu aufwendig. Im Geregelten Markt in Frankfurt werden traditionell auch Aktien gehandelt, die an anderen deutschen Börsen amtlich notiert sind. Diese werden in unseren Untersuchungen nicht einbezogen.

Infolge der Schließung des Neuen Marktes in 2003 machten viele der dort gelisteten Unternehmen von der Möglichkeit zur Zulassung zum Geregelten Markt Gebrauch. Von 2002 bis 2003 vervierfachte sich dadurch die Zahl der im Geregelten Markt notierten Aktien. In den Kern unserer Analyse beziehen wir nur die Aktien ein, die dieses Segment ursprünglich anstrebten und nicht durch die Schließung des Neuen Marktes dorthin gelangten. Dieses Vorgehen wird dadurch begründet, dass die ehemaligen Neuer-Markt-Aktien nach 2002 einen starken Einfluss auf die Entwicklung des Geregelten Marktes hatten und daher die Ergebnisse erheblich verzerren würden. Ferner ist davon auszugehen, dass sich ohne die Plattform Neuer Markt viele Unternehmen nicht für eine Börsennotierung entschieden hätten. Für viele Beteiligte war der Neue Markt ein großes Fiasko, insbesondere für die Aktionäre. Ob die darauf folgenden Änderungen der deutschen Börsenstruktur langfristig erfolgreich sein werden, kann mit wissenschaftlichen Methoden erst in mehreren Jahren beurteilt werden. Wir stufen den Neuen Markt als ein zusätzliches Segment der Frankfurter Wertpapierbörse ein, das separat analysiert werden sollte.

Zur Beantwortung der oben genannten Fragen erstellten wir in einem ersten Schritt für den Geregelten Markt eine Datenbank, welche neben den Monatsschlusskursen für die jeweils notierten Aktien sämtliche Dividenden und Kapitalmaßnahmen sowie zusätzliche Daten zu den Notizaufnahmen und Delistings für den Gesamtzeitraum der Existenz dieses Marktsegmentes von 1987 bis 2007 umfasst. In der eigentlichen Analyse führen wir Vergleiche mit dem Vorgängersegment Geregelter Freiverkehr und vor allem mit dem Amtlichen Markt in Frankfurt durch. Bei der Gegenüberstellung dieser Marktsegmente sind unter anderem die Unterschiede in Hinblick auf die institutionellen Rahmenbedingungen und die historische Herausbildung zu berücksichtigen. Diese werden im folgenden *Abschnitt 2* kurz behandelt. In *Abschnitt 3* geben wir einen Überblick zu den von uns erstellten Datenbanken, insbesondere zu den Dividenden und Kapitalmaßnahmen. In *Abschnitt 4* untersuchen wir die Primärmarkteigenschaften des Geregelten Marktes sowie die Hintergründe für das Verlassen dieses Segments. In *Abschnitt 5* werden die Kapitalkosten bzw. Aktienrenditen präsentiert und diskutiert. *Abschnitt 6* fasst die Ergebnisse abschließend zusammen.

[6] Vgl. *Andersen/Stein* (1989), S. 71 sowie die Factbooks der Deutschen Börse Group für 1997 und 2007.

2 Historisches Entwicklung und institutionelle Rahmenbedingungen

Einen der wichtigsten Aspekte der vertikalen Segmentierung der deutschen Börsen hat bereits *Max Weber* (1894) eindrucksvoll beschrieben: „[S]o haben alle größeren Börsen die Bestimmung, daß im amtlichen Kursblatt eine Notiz erst nach besonderer Zulassung des Papiers dazu stattfinden darf.“[7] Im Börsengesetz von 1896 (i. d. F. v. 22.06.1896) wurde die Zulassung zum Amtlichen Markt für die damals 29 deutschen Börsenplätze einheitlich geregelt, zudem die Festsetzung der Kurse und deren Veröffentlichung. Bis 1987 stellte der Amtliche Markt das einzige offizielle, auf dem öffentlichen Recht (Börsengesetz) basierende Marktsegment dar.

Max Weber (1894) berichtete zusätzlich, dass in den Räumlichkeiten der Börse in größerem Umfang auch andere, nicht amtlich zugelassene Aktien gehandelt wurden. Ausführlicher beschrieben und kritisch erörtert wird dieser „freie Verkehr“ von *Passow* (1922), der dabei unter anderem die Frankfurter Zeitung vom 26. August 1906 zitiert: „Die rasche Entwicklung des Aktienwesens in Deutschland hat seit mehreren Jahren […] zu einem beachtenswerten Umfang angewachsenen Handel in nicht [amtlich] notierten Werten […] herbeigeführt.“[8] *Passow* (1922) zitiert zudem die Frankfurter Zeitung vom 19. Juli 1921: „In geradezu unheimlicherweise hat sich im Laufe der jüngsten Zeit der freie Wertpapierverkehr an den deutschen Börsen entwickelt. [A]n [der] Lebhaftigkeit des Geschäfts, an Umfang der Umsätze hat er sich innerhalb der Börsenräume an manchen Tagen fast gleichbedeutend neben den offiziellen Aktienverkehr gestellt.“[9]

Der außerhalb des Amtlichen Marktes stattfindende Wertpapierhandel wurde ab circa 1912 in zwei Segmente unterteilt, ein durch die lokale Börsenordnung reguliertes Segment, für dieses bürgerte sich im Laufe der Zeit die Bezeichnung Geregelter Freiverkehr ein und ein weder dem Börsengesetz noch der Börsenordnung, wohl aber den allgemeinen Gesetzen unterliegendes Segment. Letzteres wird oft als Telefonverkehr oder als Ungeregelter Freiverkehr bezeichnet. Auf dieses Segment gehen wir in dieser Arbeit nicht weiter ein. Der Geregelte Freiverkehr war somit eine privatrechtliche Institution mit eingeschränkter Regulierung durch den Gesetzgeber. Entstanden ist er aus den Bestrebungen der Börsenteilnehmer, einheitliche Usancen für den freien Verkehr bestimmter, nicht amtlich zugelassener Werte zu schaffen.[10] Vor der offiziellen Einführung des Geregelten Marktes am 4. Mai 1987 standen den Unternehmen über viele Jahre hinweg der Amtliche Markt sowie der Geregelte und Ungeregelte Freiverkehr zur Verfügung.

Der Unterschied zwischen den Segmenten wurde unter anderem dadurch verdeutlicht, dass in den „Amtlichen Kursblättern“ der Börsen nur die Kurse der amtlich notierten Werte aufgeführt wurden. Die Kurse der Aktien, die in dem der lokalen Börsenordnung unterliegenden Freiverkehr gehandelt wurden, wurden in den „Beilagen zum Amtlichen Kursblatt“ veröffentlicht. Die

[7] Vgl. *Weber* (1894), Abschnitt Feststellung der Kurse.
[8] Vgl. *Passow* (1922), S. 57.
[9] Vgl. *Passow* (1922), S. 58.
[10] Vgl. *Stedler* (1987), S. 106-107.

Kurse der außerhalb der Börsenordnung gehandelten Aktien wurden nicht in die Amtlichen Kursblätter aufgenommen. Der Handel der letztgenannten Aktien spielte sich zwar unter Umständen auch in den Räumlichkeiten der Börsen ab, im Gegensatz zu den anderen Segmenten jedoch außerhalb der Verantwortung durch die Börsenorgane.[11] Bis 1986 wurden die Freiverkehrssegmente im Börsengesetz nicht explizit erwähnt und dementsprechend an den Börsen lediglich auf Basis des Gewohnheitsrechts geduldet.[12] Der zum 1. Mai 1988 an die Stelle des Ungeregelten Freiverkehrs tretende Freiverkehr wird zwar im Börsengesetz von 1986 erwähnt und damit gesetzlich anerkannt, aber nicht näher geregelt.[13]

Im Vergleich zum Amtlichen Markt waren die an die Unternehmen gestellten Zulassungsvoraussetzungen zum Geregelten Freiverkehr weniger restriktiv.[14] Das „Einbeziehungsverfahren" des Geregelten Freiverkehrs ähnelte zwar dem Zulassungsverfahren zum Amtlichen Markt, war aber weniger aufwendig. Die wirtschaftliche und finanzielle Unternehmenssituation musste nur in einem „Exposé" und nicht wie im Amtlichen Markt in einem Prospekt dargestellt werden. Das Exposé musste dem Freiverkehrsausschuss nur vorgelegt, jedoch nicht veröffentlicht werden. Die Frage der Haftung für die Richtigkeit der Angaben im Exposé war regional nicht einheitlich geregelt, eine Prospekthaftung wie im Amtlichen Markt gab es nicht.[15]

Trotz dieser Vereinfachungen gegenüber dem Amtlichen Markt, dem damit einhergehenden Kostenvorteil[16] und der langjährigen Existenz des Geregelten Freiverkehrs war die Zahl der ausschließlich in diesem Segment gehandelten Aktien gering.[17] Unsere Untersuchungen ergeben, dass zum Zeitpunkt der Einführung des Geregelten Marktes nur 26 Gesellschaften im Geregelten Freiverkehr in Frankfurt notiert waren.[18] Der Amtliche Markt in Frankfurt hingegen umfasste zum gleichen Zeitpunkt 222 Aktiengesellschaften. Bezüglich der Börsengänge ist festzustellen, dass es von Anfang 1980 bis Ende 1986 lediglich 13 IPOs im Geregelten Freiverkehr in Frankfurt gab. Im Amtlichen Markt in Frankfurt kam es im gleichen Zeitraum hingegen zu 34 IPOs. Prozentual betrachtet gab es in diesem Zeitraum im Amtlichen Markt im Vergleich zum Geregelten Freiverkehr jedoch nur relativ wenige IPOs (15,3 % versus 50,0 %).

In einer Vielzahl von Veröffentlichungen werden die möglichen Gründe für die geringe Nutzung des Geregelten Freiverkehrs ausführlich erörtert. *Albach/Hunsdiek/Kokalj* (1986) führten dies unter anderem auf die hohen Qualitätsanforderungen zurück, so „wird ein

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11 Vgl. *Claussen* (1985), S. 1050-1051 und *Schmidt* (1977), S. 112-114.
12 Vgl. *Damrau* (2003), S. 329 und *Claussen* (1985), S. 1061-1062.
13 Vgl. *Breitkreuz* (2000), S. 25 und S. 43.
14 Der Geregelte Freiverkehr war zwischen dem Amtlichen Markt und dem Ungeregelten Freiverkehr (dieser wird auch als Telefonverkehr bezeichnet) angesiedelt. In unseren Untersuchungen wird der Ungeregelte Freiverkehr (später Freiverkehr bzw. ab dem 10.08.2005 Open Market) nicht einbezogen.
15 Vgl. *Stedler* (1987), S. 107-108.
16 Der Kostenvorteil ergibt sich aus den geringeren Publizitätsanforderungen an die Unternehmen und halbierten Gebühren im Vergleich zum Amtlichen Markt. Vgl. *Stedler* (1987), S. 109.
17 *Albach/Hunsdiek/Kokalj* (1986, S. 62 und S. 65-67) führen dies auf eine unzureichende Segmentierung des deutschen Kapitalmarktes zurück. *Weichert* (1985, S. 4-6) und *Baums* (1995, S. 3-4) führen in diesem Zusammenhang verschiedene Nachteile der Rechtsform Aktiengesellschaft gegenüber der GmbH auf, z. B.: Kosten durch die Hauptversammlung, Trennung von Aufsichtsrat und Vorstand und die Publizitätsanforderungen.
18 Hierbei handelt es sich um Gesellschaften, die an keiner anderen Börse amtlich notiert waren.

Unternehmen kaum eine Emissionsbank finden, wenn die Qualitätsstandards wesentlich unter denen des amtlichen Marktes angesiedelt sind.“[19] *Schrader* (1993, S. 28-29) führt an, dass sich die Ortsausschüsse[20] an den Zulassungskriterien zum Amtlichen Markt orientierten. Infolgedessen ergab sich keine klare Differenzierung zwischen dem Geregelten Freiverkehr und dem Amtlichen Markt.[21] Ein weiterer oft erwähnter Grund für die unzureichende Akzeptanz des Geregelten Freiverkehrs lag im unzureichenden Anlegerschutz. So bildete das Börsengesetz nicht die rechtliche Basis für die inoffiziellen Marktsegmente und die „Preisfeststellung vollzog sich ausserhalb des dem Anlegerschutz dienenden gesetzlichen Normensystems“.[22] Daher nahmen gemäß *Stedler* (1987, S. 109) Anleger ein höheres Risiko bzw. eine geringere Sicherheit für die Hoffnung auf eine langfristig höhere Rendite in Kauf. Oft wurde argumentiert, dass die meisten Anleger diese Segmente aufgrund der institutionell bedingten Intransparenz und der daraus resultierenden Illiquidität mieden.[23] Die hohen Festbesitzanteile bzw. der geringe Streubesitz wirkten sich vermutlich ebenfalls negativ auf die Liquidität aus. Hinzu kam, dass die Investition in die Werte des Geregelten Freiverkehrs für viele institutionelle Anleger durch das Gesetz über Kapitalanlagegesellschaften (KAGG) unwirtschaftlich waren.[24]

Der Geregelte Markt wurde vom Gesetzgeber unter anderem eingeführt, um die mit den inoffiziellen Marktsegmenten verbundenen rechtlichen Probleme zu beheben.[25] Vorangegangen

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[19] Vgl. *Albach/Hunsdiek/Kokalj* (1986), S. 67. Gemäß Weichert und Baums ist die geringe Emissionsaktivität deutscher Banken unter Umständen eine Folge des Universalbankensystems und die Banken ihren Namen/Ruf mit dem Erfolg von Aktienemissionen verknüpften. „Aktiengesellschaften, deren Aktien man dem Publikum anbieten kann, ohne ein Risiko für den Ruf der Bank einzugehen, sind aber meist auch kreditwürdig. Die Bank mag deshalb dazu neigen, diesen Unternehmen Kredite zu gewähren, […] anstatt die Unternehmen an die Börse zu verweisen […].“ Vgl. *Weichert* (1985), S. 17-18; *Baums* (1997), S. 6-7; *Baums* (1995), S. 3-4. Infolgedessen traten Kreditinstitute jahrzehntelang kaum als Emissionshäuser auf. Vgl. *Albach/Hunsdiek/Kokalj* (1986), S. 81. Mit der Einführung des Geregelten Marktes wurde es den Emittenten nach § 71 Abs. 2 des BörsG i. d. F. v. 16.12.1986 ermöglicht den Zulassungsantrag von Wertpapieren für dieses Segment ohne ein begleitendes Kreditinstitut zu stellen. Vgl. *Albach/Hunsdiek/Kokalj* (1986), S. 78-79; *Stedler* (1987), S. 113. Allerdings hatte diese Gesetzesänderung bis 1997 keine praktische Bedeutung. Vgl. *Baums* (1997), S. 7 sowie Kapitel 4.1. „Bei der Finanzierung mittelständischer Unternehmen spielt die enge Beziehung zur Hausbank nach wie vor eine wesentliche Rolle.“ Vgl. *Fey/Kuhn* (2007), S. 5.

[20] Die Ortsausschüsse sind verantwortlich für die Einhaltung der Handelsusancen und die Einbeziehung neuer Wertpapiere. Vgl. *Stedler* (1987), S. 106 und *Schrader* (1993), S. 27-28.

[21] Vgl. *Albach/Hunsdiek/Kokalj* (1986), S. 67 und 77; *Weichert* (1985), S. 12; *Schmidt* (1988), S. 17. Bruns 1961, S. 108) stellt für den Geregelten Freiverkehr fest: „[d]ie Bedingungen des Handels sind weitestgehend denen des amtlichen angeglichen.“

[22] Vgl. *Rosen* (1987), S. 31; *Schrader* (1993), S. 30 zu den Details der Kursmittelung.

[23] Gemäß *Albach/Hunsdiek/Kokalj* (1986) neigen die meisten Unternehmen des Geregelten Freiverkehrs jedoch zu einer höheren Publizität, um das Anlegerinteresse zu erhalten. Vgl. *Albach/Hunsdiek/Kokalj* (1986), S. 67.

[24] § 8 des KAGG i. d. F. vom 14.01.1970 besagt zwar, dass „Investment-Gesellschaften nur Wertpapiere erwerben dürfen, die an einer deutschen Börse zum amtlichen Handel zugelassen oder in den geregelten Freiverkehr einbezogen sind.“ Vgl. *Wille* (1986), S. 7. Es dürfen allerdings (von allen Fonds einer Kapitalanlagegesellschaft) nur 5 % des Nennkapitals einer Aktiengesellschaft gehalten werden. Vgl. *Wille* (1986), S. 7; *Weichert* (1985), S. 26. Diese Auflage „[…] stellt prinzipiell ein Hindernis für Beteiligungen an kleineren Unternehmen dar, weil die Auswahl- und Überwachungskosten bei einer Beteiligung weitestgehend fix sind.“ Vgl. *Weichert* (1985), S. 28. „Eine Änderung […] des Kapitalanlagengesellschaftengesetzes erlaubt auch institutionellen Anlegern, Teile ihres Vermögens in Werten des Geregelten Markts anzulegen.“ Vgl. *Rosen* (1987), S. 31. Im KAGG i. d. F. vom 19.12.1986 wird festgehalten, dass bis zu 10 % des Nennkapitals einer Aktiengesellschaft erworben werden darf, sofern diese in einem organisierten Markt zugelassen ist.

[25] Vgl. *Stedler* (1987), S. 113 und *Hopt/Baum* (1997), S. 124. Die Einführung des Geregelten Marktes stand „[…] in engem Zusammenhang mit dem Gesetz zur Verbesserung der Rahmenbedingung für institutionelle Anleger und dem Gesetz über Unternehmensbeteiligungsgesellschaften“; zusätzlich war dieser „[…] – im Gegensatz zum Freiverkehr – in die börsen-gesetzlichen Regelungen einbezogen […].“ Vgl. *Rosen* (1987), S. 31.

war dem eine Reihe von EG-Richtlinien zur Vereinheitlichung der Kapitalmärkte, infolge derer in vielen Ländern erfolgreiche Zweitmärkte geschaffen wurden.[26] Das ursprüngliche Gesetz (BörsG i. d. F. v. 16.12.1986) integrierte den Geregelten Marktes in das bestehende Börsengesetz, wobei den jeweiligen Börsen zugestanden wurde, einzelne Bestimmungen innerhalb ihrer Börsenordnung zu regeln.[27] In diesem Gesetz wurden die Zulassungsanforderungen und die Folgepflichten für den Amtlichen Markt erörtert. Der Gesetzgeber ging davon aus, dass diese Anforderungen und Pflichten in den lokalen Börsenordnungen für den Geregelten Markt niedriger angesetzt werden. Anfänglich ergaben sich gegenüber dem Amtlichen Markt unter anderem folgende Vereinfachungen:[28]

- Ein Mindestnennwert der zuzulassenden Aktien von DM 0,5 Mio. statt DM 2,5 Mio. Der verminderte Mindestnennwert wurde von den Unternehmen allerdings nicht genutzt.[29]
- Die Zulassungsgebühren betrugen 50 % der zum Amtlichen Markt.
- Die Unternehmen mussten nicht seit drei Jahren existieren, sollte das Unternehmen noch keine zwei Jahre existieren, so musste der Gründungsbericht vorgelegt werden.
- Dem Zulassungsantrag war, anstatt eines Prospektes nur ein Unternehmensbericht beizufügen, dieser konnte, musste jedoch nicht vom Mitantragsteller unterzeichnet werden.
- Der Zulassungsantrag konnte zusammen mit einem anderen qualifizierten Emissionsbegleiter gestellt werden (im Amtlichen Markt nur zusammen mit einem Kreditinstitut).
- Die Kursfeststellung im Geregelten Markt war nicht amtlich, jedoch amtlich überwacht.
- Die Zwischenberichtspublizität galt nicht für den Geregelten Markt.

Das Börsengesetz wurde in den Folgejahren mehrmals modifiziert (1989, 1994, 1997, 1998). Dabei wurden die anfängliche Flexibilität zur Regulierung des Geregelten Marktes seitens der jeweiligen Börsen und die Vereinfachungen gegenüber dem Amtlichen Markt schrittweise zurückgenommen. Nach der Neufassung des Börsengesetzes (BörsG i. d. F. v. 21.06.2002) infolge des Vierten Finanzmarkt-Förderungsgesetzes (4. FMFG) und der einhergehenden Anpassung der Börsenordnung unterschieden sich die Zulassungsvoraussetzungen zum Geregelten Markt seit 2003 nur noch geringfügig[30] von denen zum Amtlichen Markt.[31] Zudem

[26] Vgl. *Zwaetz* (1986), S. 11; *Rosen* (1987b), S. 65; *Ebeling* (1988), S. 21; *Hopt/Baum* (1997), S. 124-125. *Rasch* (1994) und *Vismara et al.* (2012) geben eine gute Übersicht über die verschiedenen Börsensegmente an Europas Wertpapierbörsen. Allerdings erwecken *Vismara et al.* (2012, S. 355) irrtümlicherweise den Eindruck, dass der Freiverkehr in Deutschland erst 2005 eingeführt wurde.

[27] Vgl. *Stedler* (1987), S. 113. Anzumerken ist hier, dass man sich zu diesem Zeitpunkt nicht in der Lage sah, eine Anpassung an die EG-Richtlinien, welche relativ hohe Anforderungen an die Unternehmen stellten, durchzuführen. Daher wurden die Zweitmärkte, mit ihren geringen Anforderungen an die Unternehmen, so ausgestaltet, dass sie nicht unter die EG-Vorschriften fielen. Vgl. *Rosen* (1987b), S. 65.

[28] Vgl. *Schrader* (1993), S.31-33. Bis zum 01.07.1996 gab es keine wesentliche Veränderung der BörsO bzgl. der genannten Vereinfachungen gegenüber dem Amtlichen Markt. Vgl. BörsO Frankfurt vom 01.07.1996.

[29] Von den 120 IPOs im Geregelten Markt gingen lediglich die Unternehmen Hans Einhell (Vz.-A.), MLP (Vz.-A) und TC Unterhaltungselektronik (St.-A.) mit einem Nennwert unter dem des Amtlichen Marktes (DM 2,5 Mio.) an die Börse. Das durchschnittliche Grundkapital (je Aktiengattung) betrug nach dem IPO € 10,9 Mio.

[30] Die BörsO vom 01.01.2003 spezifiziert drei Unterschiede zum Amtlichen Markt: (1) Emittenten müssen für die vorangegangen drei Jahre keine Jahresabschlüsse vorgelegt haben, (2) eine Teilzulassung von Wertpapieren ist möglich und (3) keinen Mindeststreubesitz. Jedoch war dem Zulassungsantrag vorerst (geändert mit der BörsO vom 01.07.2005) weiterhin nur ein Unternehmensbericht statt eines Prospekts beizufügen.

[31] Vor dem 4. FMFG gab es bereits zahlreiche Reformen und Gesetzesänderungen mit dem Ziel, den deutschen Kapitalmarkt und insbesondere den Anlegerschutz zu stärken. Einen guten Überblick hierzu bieten *Nowak* (2001,

galten (gemäß § 71 der BörsO vom 01.01.2003) für den Geregelten Markt fast die gleichen Zulassungsfolgepflichten wie für den Amtlichen Markt. Zusätzlich wurden zum 1. Januar 2003 innerhalb der gesetzlichen Marktsegmente die beiden Teilbereiche General (Teilnahme obligatorisch) und Prime Standard eingeführt, wobei der Prime Standard zusätzliche Publizitätsanforderungen an die Unternehmen stellte. Letztendlich wurde der Geregelte Markt am 1. November 2007 infolge des Finanzmarktrichtlinie-Umsetzungsgesetzes mit dem Amtlichen Markt zusammengeführt. Das neue Segment heißt Regulierter Markt.

Weitestgehend Konsens herrscht darüber, dass die primäre Aufgabe des Geregelten Marktes darin bestand, kleinen und mittelständischen Unternehmen den Zugang zum deutschen Kapitalmarkt zu erleichtern, um unter anderem deren Eigenkapitalausstattung zu verbessern.[32] Gemäß *Wagner* (2007, S. 210.) war die Schaffung des Geregelten Marktes notwendig, da „[a]ufgrund der hohen Zulassungsvoraussetzungen des amtlichen Marktes […] für viele dieser Unternehmen der Zugang zu den Kapitalmärkten bis dato praktisch verschlossen“ blieb. Aufbauend auf einen internationalen Vergleich kam *Rosen* (1987, S. 31) zu der Schlussfolgerung, „[…] dass hierzulande ein leistungsfähiges Marktsegment fehlt, das bevorzugt mittelständischen Unternehmen die Chance bietet […] auf sich aufmerksam zu machen.“ Allerdings sind die geringe Emissionstätigkeit mittelständischer Unternehmen und die geringe Verbreitung der Aktienfinanzierung nicht ausschließlich auf eine unzureichende Börsensegmentierung und das deutsche Universalbankensystem zurückzuführen. *Albach* (1997), *Baums* (1997), *Hopt/Baum* (1997) und *Rosen* (1995) nennen hierfür eine Vielzahl weiterer Gründe, wie zum Beispiel die bis Ende 1996 fehlende Rechtsformneutralität der Besteuerung, die Benachteiligung börsennotierter Unternehmen in erbschaftssteuerlicher Hinsicht und das fehlende Interesse seitens der Emissionsbanken sowie privater und institutioneller Anleger.

Die Einführung des Geregelten Marktes ging einher mit der Zusammenführung der beiden Freiverkehrssegmente zum Freiverkehr am 1. Mai 1988. Den Unternehmen des Geregelten Freiverkehrs wurde eingeräumt innerhalb eines Jahres (bis zum 30. April 1988) in den Geregelten Markt zu wechseln.[33] So bildeten ein Jahr nach Eröffnung die ehemaligen Unternehmen des Geregelten Freiverkehrs den Schwerpunkt im Geregelten Markt.[34]

Auf den ersten Blick erschienen die Unterschiede zwischen dem Geregelten Freiverkehr und dem Geregelten Markt eher unbedeutend. Allerdings beruhte der Geregelte Markt auf einer gesetzlichen Basis.[35] Über die Zulassung zum Geregelten Markt entschied ein Zulassungs-

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2004). *La Porta et al.* (1998) kommen zu dem Ergebnis, dass der Anlegerschutz in Deutschland im internationalen Vergleich zu schwach ausgeprägt ist. Gemäß Nowak führten die Gesetzesänderungen dazu, dass sich der deutsche Kapitalmarkt bis 2003 zu einem modernen, Investor-orientierten, internationalen Standards entsprechenden Kapitalmarkt entwickelte. Vgl. *Nowak* (2004), S. 425 und S. 444-448.

32 Vgl. *Rosen* (1987), S. 31; *Pfeifer* (1988), S. 7; *Schmidt/Schrader* (1993), S. 228-231; *Süchting* (1995), S. 62.

33 Vgl. *Zwaetz* (1987b), S. 23. Hiervon machten alle bis auf vier Unternehmen Gebrauch. Von diesen Unternehmen wechselten zwei in den Freiverkehr. Die Notierung der verbleibenden zwei Unternehmen wurde eingestellt.

34 Vgl. *ohne Verfasser* (1988), S 31.

35 Der Geregelte Markt ist ein geregelter/organisierter Markt im Sinne Wertpapierdienstleistungsrichtlinie, der Geregelte Freiverkehr bzw. der Freiverkehr nicht. Vgl. *Hopt/Baum* (1997), S. 433-435.

ausschuss. Zugelassene Unternehmen unterlagen höheren Publizitätspflichten, sie mussten einen Unternehmensbericht veröffentlichen und besondere Ereignisse, die sich auf die Bonität bzw. das Betriebsergebnis des Unternehmens auswirken, unmittelbar der Öffentlichkeit bekannt geben.[36] Diese Maßnahmen sollten die Transparenz des Geregelten Marktes gegenüber dem Geregelten Freiverkehr erhöhen.[37] Somit ist es nicht verwunderlich, dass *Schmidt/Schrader* (1993) in ihren Untersuchungen positive Überrenditen für diejenigen Unternehmen feststellen, die vom Geregelten Freiverkehr in den Geregelten Markt wechselten. Allerdings war damals klar, dass der Geregelte Markt seine Funktion nur erfüllen kann, wenn sich echte Börsenneulinge für dieses Segment entscheiden.[38] Die Entscheidung könnte durch die geringeren Zulassungsvoraussetzungen und Folgepflichten gegenüber dem Amtlichen Markt begünstigt worden sein. Dies war von 1987 bis 1992 zweifelslos der Fall (vgl. *Tabelle 1*). Allerdings wird in mehreren Arbeiten konstatiert, dass der Geregelte Markt kaum einen positiven Einfluss auf die Emissionstätigkeit deutscher Unternehmen hatte.[39] Diese im Vorfeld des Neuen Marktes häufig geäußerte Einschätzung wird durch unsere Untersuchungen nicht bestätigt.[40]

Einhergehend mit der Schaffung des Geregelten Marktes wurden die Zulassungsvoraussetzungen zum Amtlichen Markt angehoben.[41] Kritische Stimmen gingen davon aus, dass einige Emittenten dies bei der Wahl des Börsensegments berücksichtigen und sich zugunsten des Geregelten Marktes und gegen den Amtlichen Markt entscheiden werden.[42] *Zwaetz* (1987b, S. 23) bemerkte, dass die ersten IPOs im Geregelten Markt im Hinblick auf das Grundkapital wohl auch im Amtlichen Markt gut aufgehoben wären.[43] Dieses Argument vernachlässigt, dass Unternehmen vor 1987 nur zwischen dem Amtlichen Markt und den Freiverkehrssegmenten wählen konnten. Vermutlich entschieden sich kleinere Aktiengesellschaften vor 1987 oftmals zugunsten des Amtlichen Marktes gegen die Freiverkehrssegmente oder zogen unter den gegebenen Umständen einen Börsengang erst gar nicht in Betracht. Aus Sicht der Deutschen Börse AG stellte der Geregelte Markt für eine Vielzahl mittelständischer Unternehmen das

[36] Vgl. *Pfeifer* (1988), S. 7. Vor Inkrafttreten des Wertpapierhandelsgesetzes (WpHG) am 01.01.1995 wurde die Ad-hoc-Publizität durch das BörsG (§ 44a Abs. 1) geregelt. Zwischen 1986 und 1993 gab es lediglich sechs Ad-hoc-Veröffentlichungen, somit war diese Regelung weitestgehend bedeutungslos. Infolge des 2. FMFG wurde die Einhaltung der Ad-hoc-Publizität unter staatliche Kontrolle gestellt. Dementsprechend stieg 1995 die Anzahl der Ad-hoc-Meldungen auf 1001 an. Vgl. *Monheim* (2007), S. 10-13; *Bacher* (2002), S. 53-54.

[37] Vgl. *Hidding* (1987), S. 25.

[38] Vgl. *Zwaetz* (1987), S. 35.

[39] Vgl. *Baums* (1995, 1997); *Rettberg* (1996); *Burghof/Hunger* (2004).

[40] In den Amtlichen Märkten aller deutscher Börsen gab es von Januar 1983 bis Mai 1987 37 IPOs und von Mai 1987 bis Dezember 1991 ebenfalls 37 IPOs. In den Geregelten Märkten aller deutschen Börsen gab es im zweiten Zeitraum 47 IPOs. Demnach gab es im Zeitraum von Mai 1987 bis Dezember 1991 47 IPOs mehr als im Zeitraum von Januar 1983 bis Mai 1987. Werden die Anzahl der IPOs für längere Zeiträume (z. B. 10 Jahre) gegenübergestellt, so schneidet der Geregelte Markt noch besser ab.

[41] Vgl. *Claussen* (1987), S. 50. Insbesondere wurden für Werte mit amtlicher Notierung die Prospektveröffentlichung in Börsenpflichtblättern und die Zwischenberichterstattung (zum 01.01.1990) vorgeschrieben. Vgl. *ohne Verfasser* (1986), S. 27; *Schmidt* (1988), S. 17-18.

[42] Vgl. *Hidding* (1987), S. 26.

[43] Unsere Daten ergeben, eine durchschnittliche Marktkapitalisierung der IPO-Aktien im Geregelten Markt zum 30.12.1987 von € 31,42 Mio. (min. € 5,11 Mio. und max. € 76,69 Mio.).

Einstiegssegment zum Amtlichen Markt dar.[44] Unsere Untersuchungen zu den Segmentwechslern bestätigen die Gültigkeit dieser Aussage (*vgl. Abschnitt 4.2*).

3 Beschreibung der Daten

Zur Erstellung einer Datenbank zum Geregelten Markt in Frankfurt werden in einem ersten Schritt alle deutschen Stamm- und Vorzugsaktien identifiziert, die zwischen dem 4. Mai 1987 und dem 31. Oktober 2007 in diesem Segment notierten.[45] Aktien, die an einer anderen Börse in einem höheren Segment, also amtlich, notierten, wie zum Beispiel die Berliner Kindl Brauerei AG, werden nicht einbezogen. Auch werden Aktien von Unternehmen, bei denen Aktien einer anderen Gattung amtlich notierten, wie bspw. die Stammaktien der Glunz AG, nicht einbezogen. Ein Großteil der einbezogenen Aktien, zum Jahresanfang 1997 52 von 79, waren an zumindest einer anderen Börse im Geregelten Markt notiert. Diese Aktien werden einbezogen, auch wenn sie an einem anderen Börsenplatz, zum Beispiel der „Heimatbörse" stärker gehandelt wurden. Bei 15 Unternehmen, deren Vorzugs- und Stammaktien gleichzeitig im Geregelten Markt notierten, werden beide Aktiengattungen einbezogen. Allerdings werden in unseren empirischen Untersuchungen die einzelnen Aktiengattungen der betroffenen Unternehmen zusammengefasst, sodass für jedes Unternehmen nur eine Beobachtung in die Untersuchungen eingeht.

Für jede Aktie wird das genaue Zugangs- und Austrittsdatum zum Geregelten Markt ermittelt. Hierfür werden insbesondere die Saling Aktienführer (1990-1995), die Hoppenstedt Aktienführer (1998-2008), die Hoppenstedt Kurstabellen (1987-1998) und die Karlsruher Kapitalmarktdatenbank (KKMDB)[46] ausgewertet. Insgesamt wurden 210 (490 inkl. ehem. Neuer-Markt-Aktien) Aktien identifiziert, die im genannten Zeitraum im Geregelten Markt gehandelt wurden und die die oben genannten Kriterien erfüllen, viele davon allerdings nur in einem Teilzeitraum. Die Kursdaten entstammen hauptsächlich der KKMDB, teilweise Datastream oder der Börsenzeitung. Unsere Kursdatenbank enthält in der Regel für jede Aktie einen Monatsschlusskurs. Aufgrund der relativ hohen Illiquidität der Aktien des Geregelten Marktes verwenden wir, soweit verfügbar, jeweils den Kurs des Börsenplatzes mit dem höchsten Börsenumsatz.[47] 74,3 % der einbezogenen Kurse entstammen dem Parketthandel der Frankfurter Wertpapierbörse, 22,6 % einer anderen deutschen Börse und 3,2 % der Datastream Datenbank. Analog zu *Stehle/Hartmond* (1991) werden Kurse nur berücksichtigt, wenn das Kursdatum größer oder gleich dem Fünfzehnten eines Monats ist.

Anschließend wurden für die Aktien des Geregelten Marktes die Dividenden, die Kapitalmaßnahmen und die zugehörigen Bereinigungsfaktoren erfasst. Herangezogen wurden

[44] Vgl. *Deutsche Börse Group* (2007b) und *Vismara et al.* (2012), S. 354. Gemäß der Deutschen Bundesbank nahm der Geregelte Freiverkehr eine ähnliche Funktion ein. Vgl. *Stedler* (1987), S. 110.
[45] Wandelanleihen, Genussscheine, junge Aktien, etc. werden nicht berücksichtigt.
[46] Vgl. *Bühler/Göppl/Möller* (1993), S. 291-303 und *Herrmann* (1996).
[47] Kurs- und Umsatzdaten zu den anderen deutschen Börsen stehen uns nur bis 2003 zur Verfügung.

hierbei neben den oben genannten Datenquellen die Termindaten der KKMDB, Archivdaten des Xetra Newsboards, das Wertpapier-Informationssystem der Börsen-Zeitung, Ad-hoc-Mitteilungen der Deutschen Gesellschaft für Ad-hoc-Publizität und die von den Unternehmen auf ihren Webseiten zur Verfügung gestellten Informationen. Fehlende Bereinigungsfaktoren für Kapitalerhöhungen aus Gesellschaftsmitteln, Nennwertumstellungen und Kapitalherabsetzungen wurden selbstständig berechnet.[48] Insgesamt wurden 891 Dividenden und 242 Kapitalmaßnahmen erfasst (*vgl. Tabelle 1*).

[Tabelle 1]

Die Anzahl der jeweils ausstehenden Aktien wurde hauptsächlich Datastream entnommen und mit den Angaben der Hoppenstedt Aktienführern geprüft bzw. ergänzt. Zusätzlich wurde die Anzahl der Aktien anhand der zuvor erhobenen Daten zu den Kapitalmaßnahmen geprüft und oftmals korrigiert. Bei der Zusammenstellung der Datenbank wurden die Daten der verschiedenen Datenquellen sorgfältig miteinander verglichen. Zusätzlich wurden diverse Plausibilitätsprüfungen durchgeführt. Ferner wurden 31 Unternehmen von uns angeschrieben und um die Überprüfung der von uns erhobenen Daten gebeten. Bisher entsprachen elf Unternehmen unserer Bitte und teilten uns in zwei Fällen kleinere Fehler mit.

Die Zahl der jeweils im Geregelten Markt gehandelten Aktien sowie die relevanten Daten zu den Dividenden und Kapitalmaßnahmen werden in *Tabelle 1* den Zahlen für den Amtlichen Markt gegenübergestellt. Die Datenbank zum Amtlichen Markt wurde erstmals in *Stehle/Hartmond* (1991) beschrieben und in den Folgejahren für den Zeitraum bis Oktober 2007 analog zur oben beschriebenen Vorgehensweise fortgeschrieben. *Brückner* (2012) enthält eine detaillierte Beschreibung der Datenbank für den Amtlichen Markt in Frankfurt. Analog zum Geregelten Markt verwenden wir für die Aktien des Amtlichen Marktes jeweils den Kurs des Börsenplatzes mit dem höchsten Börsenumsatz (sofern Börsenumsatzdaten vorhanden sind).

Im Schnitt umfasste der Amtliche Markt in Frankfurt viermal so viele Aktien wie der dortige Geregelte Markt. In diesem Vergleich wurden die ehemaligen Neuer-Markt-Aktien nicht einbezogen. Während jedoch die Zahl der Aktien im Amtlichen Markt in 2001 ihren Höhepunkt erreichte und sich bis 2007 um circa 20 % verringerte, stieg die Zahl der Aktien im Geregelten Markt fast stetig. *Tabelle 1* zeigt auch, dass die Zahl der in den beiden oberen Börsensegmenten gehandelten Aktien, zusammengenommen, zwischen 1988, kurz nach der Einführung des Geregelten Marktes, und 1997, der Einführung des Neuen Marktes, beträchtlich angestiegen ist. Anfang 1988 waren in beiden Segmenten zusammen 282 Aktien gelistet, Anfang 1997 431, ein Anstieg um 52,84 %, 4,83 % pro Jahr.

Darüber hinaus werden in *Tabelle 1* die Anzahl der Penny Stocks für beide Marktsegmente dargestellt. Der Begriff Penny Stock bezeichnet im Allgemeinen eine Aktie mit einem sehr

[48] *Sauer* (1991) gibt einen guten Überblick zur Berechnung der Bereinigungsfaktoren.

niedrigen Kurs und einem sehr niedrigen Marktwert des Eigenkapitals.[49] Wir verstehen unter einem Penny Stock eine Aktie mit einem Kurs unter 1,00 € und einer Marktkapitalisierung unter € 5 Mio. Unsere Daten zeigen, dass es unter den Geregelter-Markt-Aktien erst seit Oktober 2000 Penny Stocks gab, allerdings beträgt deren Anteil zwischen Oktober 2000 und Oktober 2007 im Schnitt 14 % (*vgl. Tabelle 1*). Im Amtlichen Markt beträgt der Penny-Stock-Anteil im gleichen Zeitraum lediglich 5 %.[50] Einige Börsen, wie zum Beispiel die NASDAQ nehmen Penny Stocks, Aktien mit einem dauerhaften Kurs von unter 1,00 $, von der Börse.[51] Die Deutsche Börse AG versuchte ebenfalls Penny Stocks vom Neuen Markt auszuschließen.[52] In unseren Untersuchungen schließen wir Penny Stocks zum Teil aus, weisen jedoch an der entsprechenden Stelle darauf hin.

Der Anteil der Dividenden ausschüttenden Unternehmen war im Amtlichen Mark mit durchschnittlich 78,3 % gegenüber 57,0 % im Geregelten Markt deutlich höher. Bis circa 1993 was das Ausschüttungsverhalten in beiden Segmenten ähnlich, circa dreiviertel der Unternehmen schütteten in dieser Zeit Dividenden aus. Ab 1994 fiel der Prozentsatz der ausschüttenden Unternehmen im Geregelten Markt fast stetig auf circa 33,3 % in 2007. Ein Teil dieses Rückgangs hängt möglicherweise damit zusammen, dass seit 2003 im Schnitt circa 17,6 % der Aktien als Penny Stocks einzustufen sind. Bei den Kapitalmaßnahmen, insbesondere bei Kapitalerhöhungen mit Bezugsrecht, gab es prozentual betrachtet keine wesentlichen Unterschiede (*vgl. Tabelle 1*). Demnach war der Zugang zu neuem Kapital für die Unternehmen des Geregelten Marktes im Rahmen von Bezugsrechtsemissionen mit denen der Unternehmen des Amtlichen Marktes vergleichbar.

Zur Darstellung der Größencharakteristika der im Geregelten Markt notierten Unternehmen haben wir diese in vier Size-Portefeuilles unterteilt. Die Size-Portefeuille-Grenzen werden jeweils zum Jahresende für das Folgejahr bestimmt. Wir fassen die marktwertmäßigen größten 5 % aller Unternehmen, von denen wir glauben, dass diese aufgrund ihrer Größe atypisch für den Geregelten Markt sind im Portefeuille „Top-5%" zusammen.[53] Die Size-Portefeuilles D01 (Micro) bis D03 (Small) enthalten jeweils circa ein Drittel der verbleibenden Unternehmen (*vgl. Tabelle 2*). Penny Stocks werden den Größenklassen nicht zugeordnet.

[Tabelle 2]

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49 Gemäß der Securities and Exchange Commission (SEC) bezieht sich der Terminus Penny Stocks auf spekulative 'Low-Priced' (unter 5,00 $) Wertpapiere sehr kleiner Unternehmen. Vgl. *Penny Stock Rules*, URL: www.sec.gov/answers/penny.htm, 14.10.2008. In der Literatur wird häufig ein Kurs von unter 1,00 € angegeben.

50 Bei der Mehrheit der Penny Stocks handelt es sich um die Aktien insolventer Unternehmen.

51 NASDAQ Stock Market Rules, Rule 4000 Marketplace Rules, The Bid Price Requirement, URL: http://cchwallstreet.com/nasdaq, 14.10.2008.

52 Allerdings gelang es den betroffenen Unternehmen sich gegen dieses Vorgehen mittels einstweiliger Verfügungen zu wehren, zum 29.10.2001 hatten bereits 18 Unternehmen eine Verfügung erwirkt und 30 weitere Verfahren waren anhängig. Vgl. *Manager-Magazin* (2001): Triumph der Penny-Stocks, URL: http://www.manager-magazin.de/finanzen/artikel/0,2828,164556,00.html, 18.06.2012.

53 Im Schnitt ist die Marktkapitalisierung der Unternehmen in Top-5% fünfmal so hoch wie die von D03.

Tabelle 2 gibt einen Überblick zu den Charakteristika der vier Size-Portefeuilles. Anfang 2004 kam es im Size-Portefeuille Top-5% zu einem sprunghaften Anstieg der Marktkapitalisierung, dieser ist hauptsächlich auf die Segmentwechsel der DEPFA Deutsche Pfandbriefbank AG[54] mit einer Marktkapitalisierung von € 2.988 Mio. (nominal) und der Lechwerke AG mit einer Marktkapitalisierung von € 1.577 Mio. (nominal) aus dem Amtlichen Markt in den Geregelten Markt zurückzuführen. Anfang 2007 war die SolarWorld AG, welche bis 2003 im Geregelten Freiverkehr notierte, das marktwertmäßig größte Unternehmen im Geregelten Markt. Insbesondere zeigt *Tabelle 2* die große Streubreite der Marktkapitalisierungen. Während die kleinsten Unternehmen in D01 eine Marktkapitalisierung von unter € 10 Mio. besitzen, existieren gleichzeitig Unternehmen die um ein vielfaches größer sind. Ferner geht aus den Marktwertgrenzen für Portefeuille D01 hervor, dass die kleinsten Unternehmen im Zeitablauf kleiner wurden. Bei einigen dieser Unternehmen beträgt die Marktkapitalisierung nach 2003 weniger als € 1 Mio.

Darüber hinaus enthält *Tabelle 2* Informationen zu der Verteilung der IPOs im Geregelten Markt auf die vier Size-Portefeuilles. Die meisten IPOs entfallen dabei auf die Size-Portefeuilles D03 (43,1 %) und D02 (32,8 %). Die Hälfte (50,0 %) der IPOs sind den beiden Size-Portefeuilles der größten Unternehmen, D03 und Top-5%, zuzuordnen. Die durchschnittliche Marktkapitalisierung der IPOs am Monatsende der Börseneinführung beträgt circa € 103 Mio. Lediglich 3,1 % der IPOs im Geregelten Markt hatten zum Monatsende nach Börseneinführung eine Marktkapitalisierung von unter € 10 Mio. Die meisten Unternehmen hätten demnach die Voraussetzungen für den Amtlichen Markt erfüllt.[55]

4 Zu- und Abgänge

4.1 Zugänge zum Geregelten Markt

Bei der Betrachtung der Zugänge zum Geregelten Markt in *Abbildung 1* differenzieren wir zwischen Börsenneulingen und Unternehmen, die bereits an einer anderen Börse oder in einem anderen Segment notiert waren. Bei den Börsenneulingen unterscheiden wir zwischen „reinen“ Notizaufnahmen und Notizaufnahmen mit begleitender Kapitalerhöhung, nur letztere bezeichnen wir als IPO. Die spätere Einführung einer weiteren Aktiengattung klassifizieren wir nicht als IPO.[56] Innerhalb des ersten Jahres (Mai 1987 bis Mai 1988) nahmen die meisten Unternehmen des Geregelten Freiverkehrs die Möglichkeit wahr, in den Geregelten Markt zu wechseln, 1987 wechselten 13 Unternehmen und 1988 neun Unternehmen. Zusätzlich kamen 1988 zwei Aktien aus dem Ungeregelten Freiverkehr in Frankfurt und vier aus dem Geregelten Markt anderer Börsen hinzu. Diese Unternehmen bildeten bis Anfang 1990 den Kern des

[54] Die Notierung der DEPFA wurde zum 09.02.2005 infolge eines Squeeze-outs der Minderheitsaktionäre durch den Hauptaktionär, der DEPFA Bank PLC (ISIN: IE0072559994), eingestellt.

[55] Vgl. hierzu auch Fußnote 29.

[56] Für eine ausführlicherer Diskussion des IPO-Begriffs vgl. *Schenek* (2006), S. 9-11. In Statistiken werden oft alle der genannten Zugänge als IPO bezeichnet. Z. B. wird 2006 die Lang & Schwarz Wertpapierhandelsbank von der DAI als IPO kategorisiert, obwohl dieses Unternehmen im Rahmen der Notizaufnahme keine Kapitalerhöhung durchführte. Ferner beziehen das DAI und die Deutsche Börse Group auch ausländische Aktien in ihren IPO-Listen ein, wie bspw. 2006 die österreichische BDI – BioDiesel International.

Geregelten Marktes. Bereits Ende 1990 bildeten Börsenneulinge die Mehrheit der notierten Aktien (*vgl. Abbildung 1*).[57]

[Abbildung 1]

Insgesamt wechselten zwischen 1987 und 2007 66 Aktien in den Geregelten Markt, diese Aktien waren zuvor an einer anderen Börse und/oder einem anderen Marktsegment notiert. Hierbei handelt es sich um 42 Zgänge aus den Freiverkehrssegmenten, 22 Aktien, die bereits an einer anderen deutschen Börse im Geregelten Markt gehandelt wurden und 2 Aktien aus dem Amtlichen Markt (DEPFA AG und Lechwerke AG). Zugänge von anderen Börsen behielten fast immer ihre Notiz an der anderen Börse aufrecht. Dreizehn Unternehmen führten eine weitere Aktiengattung ein und zwei nahmen ihre Notierung nach einer Fusion im Geregelten Markt auf. Börsenneulinge stellen mit 129 Aktien den größten Anteil der Zugänge zum Geregelten Markt dar. Hierbei handelt es sich um 120 IPOs (118 Unternehmen) und 9 „reine" Notizaufnahmen. Im Schnitt gab es demnach circa sechs IPOs pro Jahr. Die Zahl der IPOs schwankt allerdings stark im Zeitablauf, 1990 gab es 14 IPOs, 2003 keinen IPO am Geregelten Markt.

Insgesamt gelangten 210 Aktien (190 Unternehmen) an den Geregelten Markt, weitere 288 Aktien kamen zwischen Anfang 2001 und Mitte 2003 aus dem Neuen Markt hinzu (22 bis Ende 2001, 75 in 2002 und 191 in 2003).[58] Im Juli 2003 umfasste der Geregelte Markt 97 „reine" Geregelter-Markt-Unternehmen mit einer durchschnittlichen Marktkapitalisierung von € 60 Mio., demgegenüber stehen 281 ehemalige Neuer-Markt-Unternehmen mit einer durchschnittlichen Marktkapitalisierung von circa € 100 Mio., die nun ebenfalls im Gergelten Markt notiert sind. Dies ergibt einen marktwertmäßigen Anteil der reinen Geregelter-Markt-Unternehmen im Juli 2003 von lediglich 17,21 %. Die starke Gewichtung der ehemaligen Neuer-Markt-Aktien im Geregelten Markt verdeutlicht die Notwendigkeit der getrennten Betrachtung beider Aktiengruppen.

Im Amtlichen Markt gab es im gleichen Zeitraum 163 IPOs, im Durchschnitt 7,8 IPOs pro Jahr (*vgl. Tabelle 1*). Bezieht man die Anzahl der IPOs auf die jeweils zum Jahresanfang ausstehenden Aktien, so schnitt der Geregelte Markt als Primärmarkt mit dem Durchschnittswert 8,94 % gegenüber dem Amtlichen Markt mit 2,18 % für den Zeitraum von 1988 bis 2007 beträchtlich besser ab. Andere Beobachter sind bezüglich der Anzahl der IPOs am Geregelten Markt weniger zufrieden.[59] Allerdings ist die Anzahl der IPOs in Deutschland im

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57 Infolge der Börsenneuzugänge nahm die durchschnittliche Marktkapitalisierung von Dezember 1987 bis 1990 deutlich zu, von € 29,853 Mio. auf € 84,438 Mio. Ohne die Börsenneuzugänge wäre die durchschnittliche Marktkapitalisierung lediglich auf € 46,788 Mio. gestiegen.

58 Inkl. der drei Aktien, die zuvor aus dem Geregelten Markt in den Neuen Markt wechselten.

59 Vgl. *Rosen* (1995); S. 374 sowie S. 386; *Rettberg* (1996), S. 44; *Hopt/Baum* (1997), S. 357; *Kaufmann/Kokalj* (1996), S. 26; *Burghof/Hunger* (2003), S. 4; *Hunger* (2003), S. 15-16; *Engelhardt* (2007), S. 2. Studien des DAI argumentieren, dass in Deutschland noch ein erhebliches IPO-Potenzial besteht. Zwar können sich ca. 18,5 % (2003) bzw. ca. 23 % (2007) der befragten Unternehmen einen Börsengang vorstellen, jedoch scheuen insbesondere mittelständisch geprägte Unternehmen den Börsengang. Vgl. *Wetzel* (2003), S. 11; *Fey/Kuhn* (2007), S. 18 und S. 43.

internationalen Vergleich, insbesondere im Vergleich zu den angelsächsischen Ländern, generell sehr gering.[60]

Die möglichen Ursachen hierfür sind vielschichtig und wurden in der Literatur bereits ausführlich diskutiert.[61] Häufig wird aufgeführt, dass das deutsche Finanzsystem bankendominiert, das angelsächsische hingegen marktdominiert ist.[62] *Baums* (1997, S. 6-8.) führt in diesem Zusammenhang unter anderem die Zurückhaltung der Emissionsbanken auf (aufgrund des Reputations-, des Prospekthaftungs- und des Risikos auf den Aktien sitzen zu bleiben) und dass in Deutschland nur Aktiengesellschaften an den Börsen zugelassen werden. „Viele kleine und mittlere Unternehmen schrecken jedoch vor der Umwandlung in eine Aktiengesellschaft zurück."[63] *Kaufmann/Kokalj* (1996, S. 33) argumentieren, dass der Börsengang in Deutschland eher als Möglichkeit zur Realisierung eines Teils des Unternehmenswertes betrachtet wird und nicht zur Aufnahme von Wachstumskapital. Zudem wird häufig erwähnt, dass die Altersversorgung in Deutschland hauptsächlich auf dem Umlage- und nicht dem Kapitaldeckungsverfahren basiert. Aktien spielen somit in Deutschland im Gegensatz zum angelsächsischen Raum im Rahmen der Altersvorsorge eine geringere Rolle. Dies würde auch die geringe Nachfrage nach Börsenneulingen seitens inländischer Investoren erklären. So fanden 1995 an den deutschen Börsen nur 20 bis 25 % der Aktien von Börsenneulingen inländische Käufer.[64]

In Anbetracht der erwähnten starken Zunahme der im Amtlichen Markt und im Geregelten Markt notierten Aktien (um 52,8 %) zwischen Anfang 1988 und Anfang 1997 teilen wir nicht die Ansicht der erwähnten Beobachter, dass die Zahl der Börsengänge in diesem Zeitraum wesentlich unter der für Deutschland gesamtwirtschaftlich optimalen Zahl liegt. Eher dürfte die Gesamtzahl der IPOs im Amtlichen Markt, Geregelten Markt und Neuen Markt zwischen Anfang 1997 und Ende 2000 wesentlich über der optimalen Zahl liegen.

4.2 Abgänge aus dem Geregelten Markt

Im Zeitraum des Bestehens des Geregelten Marktes schieden 96 Aktien aus diesem Segment aus (*vgl. Abbildung 2*). Dies entspricht bei 210 Aktien einem prozentualen Anteil von circa 45,7 %. Im Amtlichen Markt kam es prozentual betrachtet zwar zu ähnlich vielen Delistings (44,8 %), jedoch unterscheiden sich die Gründe für die Delistings in beiden Marktsegmenten zum Teil erheblich (*vgl. Tabelle 3*). Hinzu kommt, dass derartige Ereignisse die Gesamtperformance des jeweiligen Marktsegments beeinflussen. Wir versuchen die Auswirkung eines potenziellen Ex-

[60] Beispielsweise untersucht *Loughran/Ritter* einen Datensatz von 4.882 IPOs für den amerikanischen Markt (im Schnitt 287 IPOs pro Jahr). Vgl. *Loughran/Ritter* (2004), S. 15.
[61] Vgl. *Giersch/Schmidt* (1986); *Albach* (1996); *Kaufmann/Kokalj* (1996); *Schmidt* (1996); *Albach/Köster* (1997); *Baums* (1997); *Theissen* (2004).
[62] Allerdings erfreuen sich insbesondere infolge der Finanz- und Wirtschaftskrise alternative Finanzierungsformen wie Schuldscheine, Unternehmensanleihen, etc. steigender Beliebtheit. Vgl. *Seibel* (2010) und *Achleitner et al.* (2011).
[63] Vgl. *Baums* (1997), S. 7.
[64] Vgl. *Albach* (1996), S. 6, welcher sich auf „Die Welt" vom 13.02.1996 bezieht.

post-Selection-Bias auf die Durchschnittsrendite des Geregelten Marktes zu quantifizieren. Hierfür wird für jede der im folgenden genannten Delisting-Kategorien untersucht, welchen Einfluss ein Ex-post-Ausschluss (Ex-post-Selection-Bias) der betroffen Aktien auf die marktwertgewichtete Durchschnittsrendite hätte.

Gemäß *Zillmer* (2003, S. 25-27) unterscheiden wir zwischen partiellen – die Einstellung der Börsennotierung an einer Börse oder einem Börsensegment – und vollständigen Delistings. Zu den partiellen Delistings zählen Börsenwechsel bzw. der Rückzug von einem Börsenplatz (Börsenpräsenzreduktion) im Rahmen der horizontalen Segmentierung und Segmentwechsel im Rahmen der vertikalen Segmentierung (zum Beispiel Aufstieg in den Amtlichen Markt oder Abstieg in den Freiverkehr). Bei einem vollständigen Delisting ist eine weitergehende Kategorisierung bezüglich verschiedener Rechtsnachfolgeformen, dem Fortbestand der ehemals börsennotierten Gesellschaft sowie der Freiwilligkeit der Transaktion (wurde der Delistingprozess durch die Gesellschaft initiiert) möglich. Durch die Unternehmenseigentümer initiierte vollständige Rückzüge von der Börse werden hierbei als Going Private bezeichnet.[65] Neben den Börsen-/Segmentwechsel und Going-Private-Transaktionen spielten unter anderem Insolvenzen und Aktienumwandlungen (Umtausch von Vorzugsaktien in Stammaktien) eine wichtige Rolle am Geregelten Markt (*vgl. Tabelle 3*).[66] Bei der Zuordnung der Unternehmen zu den einzelnen Kategorien wurde jeweils das Ereignis, das unmittelbar zum Delisting im Geregelten Markt führte, ausgewählt.[67]

[Abbildung 2 und Tabelle 3]

Börsen- und Segmentwechsel

Der Geregelte Markt wurde oftmals als Einstiegssegment zum Amtlichen Markt bezeichnet. Gemessen an der Zahl der Segmentwechsel in den Amtlichen Markt ist dies durchaus nachvollziehbar, von den 210 Aktien (190 Unternehmen) des Geregelten Marktes wechselten 41 (34 Unternehmen) also 19,5 % aller Aktien in den Amtlichen Markt (*vgl. Tabelle 3*). Lediglich drei Unternehmen wechselten in den Freiverkehr bzw. Open Market und weitere drei in den Neuen Markt.[68] Allerdings handelte es sich nicht bei allen Unternehmen um einen „klassischen" Wechsel in den Amtlichen Markt. Beispielsweise wurde die amtlich notierte VDN AG durch die bis dahin im Geregelten Markt notierte Langbein-Pfanhauser AG übernommen, welche anschlie-

[65] *Zillmer* (2003, S. 23) beschreibt ein Going Private als „[…] das selbst beschlossene und vollständige Delisting einer börsennotierten Gesellschaft, wobei als Rechtsnachfolger eine nicht börsennotierte Gesellschaft den Fortbestand des ehemals börsennotierten Unternehmens als rechtlich selbstständiges Unternehmen gewährleistet."

[66] Delistings bzw. der Widerruf der Zulassung seitens der Frankfurter Wertpapierbörse traten im Untersuchungszeitraum weder für den Amtlichen Markt noch für den Geregelten Markt auf.

[67] Bspw. wurde für die Feedback AG am 02.12.2002 das Insolvenzverfahren eröffnet. Die Notierung der Aktie wurde jedoch mit Ablauf des 04.03.2005 seitens der Deutschen Börse AG aufgrund einer vorangegangen Kapitalherabsetzung des Grundkapitals auf 0,00 € im Rahmen der Restrukturierung eingestellt. Als Ziel der Restrukturierung wurde u. a. angegeben, die Aktiengesellschaft für eine Manteltransaktion zu nutzen. Am 02.03.2006 erfolgte die Wiederaufnahme der Notierung im Open Market. Das Ereignis, welches zum Delisting der Aktie führte, war somit nicht die Insolvenz, welche zum 01.09.2004 abgewendet wurde, sondern die Einstellung der Notierung seitens der Frankfurter Wertpapierbörse. Vgl. *Hock/Meier* (2007), S. 33.

[68] Die drei Unternehmen Bertrandt (Notierungsaufnahme ohne Kapitalerhöhung 1996), A.I.S. (IPO 1996) und Mühl Product & Service (IPO 1995) wechselten vom Geregelten Markt an den Neuen Markt.

ßend den Namen und die amtliche Notierung der VDN AG übernahm. Den Wechsel vom Amtlichen Markt in den Geregelten Markt vollzogen hingegen lediglich zwei Aktiengesellschaften.

Der Wechsel in den Amtlichen Markt könnte im Rahmen der Signalling-Theorie als ein Qualitätssignal interpretiert werden, da das Unternehmen bereit ist, sich den höheren Anforderungen des Amtlichen Marktes zu stellen. Die Einführung der beiden Teilbereiche General und Prime Standard, in Verbindung mit der rückläufigen Differenzierung zwischen den öffentlich-rechtlichen Marktsegmenten (*vgl. Abschnitt* 2), räumte den Unternehmen ab 2003 eine Alternative zum Segmentwechsel ein. Anstelle der obligatorischen Zulassung zum General Standard konnte die Zulassung zum Prime Standard, der höhere Zulassungsfolgepflichten an die Unternehmen stellt, beantragt werden. In diesem Kontext sollten Segmentwechsel vom Geregelten Markt in den Amtlichen Markt ihre Signalwirkung weitestgehend verloren haben. Unsere Untersuchungen zeigen, dass nach dem 1. Januar 2003 keine weiteren Aktien in den Amtlichen Markt wechselten. Insgesamt handelt es sich bei den Aufsteigern um Unternehmen mit einer überdurchschnittlich guten Entwicklung. Hätten sich die betroffenen Aktiengesellschaften von Anfang an für die Notierung im Amtlichen Markt entschieden, so würde sich die jährliche marktwertgewichtete Durchschnittrendite des Geregelten Marktes um 3,28 Prozentpunkte verringern. Dieser starke Effekt ist unter anderem darauf zurückzuführen, dass die Aufsteiger sowohl zu den marktwertmäßig größeren als auch erfolgreicheren Aktien gehörten.[69]

Going-Private-Transaktionen

Der prozentuale Anteil der Delistings infolge von Going-Private-Transaktionen ist im Geregelten Markt mit 11,7 % (24 Ereignisse) deutlich geringer als im Amtlichen Markt mit 20,6 % (119 Ereignisse). Die Häufigkeit der Ereignisse, in denen die Minderheitsaktionäre herausgedrängt wurden, stieg, nachdem der Gesetzgeber die gesetzlichen Rahmenbedingungen für die schnelle Durchführung eines derartigen Verfahrens – das sogenannte Squeeze-out – geschaffen hat, an. Die Squeeze-out-Regelung wurde am 1. Januar 2002 in das Aktiengesetz aufgenommen. Seitdem gab es immerhin 16 Squeeze-outs am Geregelten Markt, wohingegen es in den Jahren zuvor lediglich zu fünf vergleichbaren Transaktionen kam. Im Amtlichen Markt spielten Squeeze-outs (16,6 %) eine stärkere Rolle als im Geregelten Markt (7,8 %) (*vgl. Tabelle 3*).

Im Rahmen von Going-Private-Transaktion speziell von Squeeze-outs ist zu berücksichtigen, dass die beteiligten Aktien bereits im Vorfeld einen sehr geringen Streubesitz und dementsprechend eine sehr geringe Liquidität aufweisen. Ein Kauf der betroffenen Aktien ist demnach nicht immer einfach. Dies ist bei der Berechnung von Durchschnittsrenditen gegebenenfalls zu beachten. In diesem Zusammenhang stellt sich erneut die Frage, inwiefern derartige Transakti-

[69] Ca. zwei Drittel der Segmentwechsler (22 Unternehmen bzw. 28 Aktien) sind den Size-Portefeuilles D03 und Top-5% zuzuordnen. *Rasch* (1994, S. 24) stellt fest, dass die erfolgreichen Aktien in den Amtlichen Markt wechseln, wohingegen die weniger erfolgreichen im Geregelten Markt verbleiben.

onen die Performance des Marktsegments beeinflussen. *Elsland/Weber* (2005, S. 15) zeigten, dass Squeeze-out-Ankündigungen in Deutschland von positiven abnormalen Renditen (circa 5 %) begleitet werden. Werden die Unternehmen, die den Geregelten Markt infolge eines Going Privates verließen, ex post bei der Berechnung der jährlichen marktwertgewichteten Durchschnittrendite des Geregelten Marktes ausgeschlossen, so verringert sich diese um 0,51 Prozentpunkte.

Insolvenzen und Liquidationen

Die Anzahl der Delistings infolge von Insolvenzen ist mit 4,9 % prozentual etwas höher als im Amtlichen Markt mit 1,4 % (*vgl. Tabelle 3*).[70] Bis zum 31. Oktober 2007 wurden insgesamt 27 Insolvenzverfahren im Geregelten Markt eröffnet.[71] Dies entspricht bei 190 Unternehmen circa 14,2 %. Im Amtlichen Markt kam es bis zum 31. Oktober 2007 insgesamt zu 36 Insolvenzen, dies entspricht bei 501 Unternehmen circa 7,2 %.

Typischerweise wird eine Insolvenz von einem starken Kursrückgang begleitet. Proportional mit dem Kursverfall geht auch die Marktkapitalisierung zurück, sodass der Einfluss dieser Unternehmen auf einen marktwertgewichteten Index sehr gering ist. Allerdings führt der vorangegangene Kursverfall zu einer Minderung der Indexperformance. So kommt es bei einem Ex-post-Ausschluss von Unternehmen, die ein Insolvenzverfahren beantragt haben, zu einer Zunahme der jährlichen marktwertgewichteten Durchschnittrendite des Geregelten Marktes von 2,41 Prozentpunkten.

Fusionen

Im Geregelten Markt gab es lediglich zwei Delistings infolge von Fusionen, hierbei handelte es sich um die AGFB AG und KIH AG (für letztere notierten Vorzugs- und Stammaktien). Im Amtlichen Markt kam es hingegen zu 68 (11,8 %) Delistings infolge von Fusionen, welchen hier eine hohe Bedeutung zukommt. Dementsprechend ist der prozentuale Anteil an Delistings infolge von Fusionen im Amtlichen Markt wesentlich höher als im Geregelten Markt (*vgl. Tabelle 3*).[72]

Aktienumwandlungen

Die Akzeptanz der Vorzugsaktie ist gemäß *Gerig* (2003) auf den Dividendenvorzug zurückzuführen, welcher insbesondere für Anleger, für die der Stimmrechtsverlust irrelevant ist, lukrativ

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[70] Diese Beobachtung steht im Einklang mit *Stehle* (1997, S. 68), der für den Amtlichen Markt im Zeitraum von 1961 bis 1989 lediglich sechs Notizeinstellungen infolge von Konkursen feststellte. Allerdings wurden für den Amtlichen Markt keine weiteren Untersuchungen hinsichtlich der eröffneten Insolvenzverfahren durchgeführt, sodass hierzu keine eindeutige Aussage möglich ist.

[71] Von diesen konnten drei (Rheiner Moden, Arques Industries und COLEXON Energy) im Rahmen einer Manteltransaktion abgewendet werden. Eine Insolvenz (German Brokers) wurde aufgrund eines erfolgreichen Insolvenzplans aufgehoben, jedoch stellte diese zum 13. März 2008 erneut einen Insolvenzantrag. Nach Schließung des Geregelten Marktes beantragten bis Juli 2008 vier weitere Unternehmen Insolvenz. Hierbei handelt es sich um Köhler & Krenzer Fashion, ARQUANA International Print & Media und Private Value und German Brokers. Stand: Juli 2008.

[72] *Stehle* (1997, S. 67) stellte ebenfalls fest, dass Notizeinstellungen im Amtlichen Markt hauptsächlich auf Fusion und Akquisitionen zurückzuführen sind.

ist. Allerdings ist gemäß *Daske/Ehrhardt* (2002) die sich aus dem Dividendenvorteil ergebende Dividendenrendite gering, sodass sich keine signifikanten Unterschiede in der Gesamtrendite ergeben.[73] Zudem besteht vor dem Hintergrund der Internationalisierung der Kapitalmärkte und dem einhergehenden Druck institutioneller Investoren der Trend zur Umwandlung der Vorzugs- in Stammaktien.[74] Dabei handelt es sich in der Regel nicht um ein Delisting des Unternehmens, da dieses weiterhin börsennotiert bleibt. Am Geregelten Markt kam es insgesamt zu 13 Umwandlungen von Vorzugs- in Stammaktien. In fünf Fällen wurden dabei die Vorzugsaktien in zuvor nicht börsennotierte Stammaktien umgetauscht. Im Amtlichen Markt gab es prozentual ähnlich viele Aktienumwandlungen (5,4 %) wie im Geregelten Markt (4,3 %) (*vgl. Tabelle 3*).

5 Empirische Untersuchungen

5.1 Das Marktportefeuille

In empirischen Studien für den deutschen Kapitalmarkt wird oftmals das Portefeuille aller im Amtlichen Markt in Frankfurt notierten Aktien als Marktportefeuille verwendet (zum Beispiel die Stehle/Hartmond-Reihe, der DAFOX oder der CDAX). Der Amtliche Markt wird von 1954 bis 1988 durch die *Stehle/Hartmond*-Reihe und von 1974 bis Ende 2004 durch den DAFOX erfasst.[75] Die *Stehle/Hartmond*-Reihe basiert ab 1988 auf dem CDAX. Der DAFOX wird in empirischen Arbeiten ebenfalls oftmals mit dem CDAX (ab 2005) verketten. Der bis 1970 zurückreichende CDAX erstreckte sich bis September 1998 nur auf die Aktien des Amtlichen Marktes.[76] Ab dem 21. September 1998 wurden auch die Aktien des Neuen Marktes und des Geregelten Marktes in den CDAX einbezogen.[77] Ein wichtiger Aspekt bei der Wahl des Marktportfolios ist die Behandlung der Körperschaftsteuergutschrift[78]. Die Einbeziehung der Körperschaftsteuergutschrift ist von Bedeutung, da die Aktien des Geregelten Marktes im Schnitt weniger Dividenden ausschütteten als die des Amtlichen Marktes (*vgl. Tabelle 1*). Letztendlich würde bei einer Nichteinbeziehung der Körperschaftsteuergutschrift die Performance des Amtlichen Marktes im Vergleich zum Geregelten Markt systematisch unterschätzt werden. Im Gegensatz zum CDAX und dem DAFOX wird die Körperschaftsteuergutschrift durch die *Stehle/Hartmond*-Reihe berücksichtigt.[79]

Aus unserer Sicht bildet derzeit keine Zeitreihe die langfristige Performance der Aktien des Amtlichen Marktes mit einer hinreichenden Genauigkeit ab. Der DAFOX und der CDAX beziehen die Körperschaftsteuergutschrift nicht ein. Die Zusammensetzung des CDAX und

[73] Vgl. *Daske/Ehrhardt* (2002), S. 31.
[74] Vgl. *Gerig* (2003), S. 104; *Daske/Ehrhardt* (2002), S. 3.
[75] Zur Berechnung der *Stehle/Hartmond*-Reihe vgl. *Stehle/Hartmond* (1991), DAFOX vgl. *Göppl/Schütz* (1995).
[76] Bis zum 31.12.1987 basiert der CDAX auf den Indexwerten des FWB-Index, ein Kursindex, der Dividenden nicht berücksichtigt. Vgl. *Rosen* (1993), S. 43.
[77] Vgl. *ohne Verfasser* (1998), S. 26.
[78] Deutsche Aktionäre erhielten eine Körperschaftsteuergutschrift auf Dividenden, diese betrug von 1977 bis 1993 i. d. R. 9/16 (56,25 %) und von 1994 bis 2000 3/7 (42,86 %) der Bardividende.
[79] Im Gegensatz zur *Stehle/Hartmond*-Reihe und dem DAFOX ist eine vollständige Dokumentation für den CDAX, insbesondere zur Rückberechnung für die Jahre 1970 bis 1993 nicht zugänglich. Daher ist es z. B. unklar ob der CDAX zwischen 1970 und 1993 einen Ex-post-Selection-Bias beinhaltet.

damit einhergehend die der *Stehle/Hartmond*-Reihe ändern sich im Zeitablauf. Aus diesen Gründen verwenden wir eine eigens für der den Amtlichen Markt berechnete marktwertgewichtete Renditezeitreihe. Konzeptionell entspricht diese Zeitreihe der *Stehle/Hartmond*-Reihe, d. h. es werden ausschließlich deutsche Aktien, die im Amtlichen Markt in Frankfurt notiert sind berücksichtigt. Zusätzlich wird bei der Berechnung dieser Zeitreihe die Körperschaftsteuergutschrift einbezogen. Diese Zeitreihe wird unter anderem von *Brückner/Lehmann/Stehle* (2012) und *Brückner* (2012) verwendet. Im weiteren bezeichnen wir diese Zeitreihe für den Amtlichen Markt in Frankfurt als AMX-Zeitreihe.

Einige empirische Studien wie zum Beispiel *Kothari/Shanken/Sloan* (1995) verwenden gleichgewichtete Indizes als Proxy für das Marktportefeuille. In der Praxis gewinnen gleichgewichtete Indizes in letzter Zeit ebenfalls an Bedeutung, so werden bspw. der S&P 500 Index (seit 2003) und der MSCI World Index (seit 2008) zusätzlich als gleichgewichtete Indizes berechnet.[80] Allerdings steht ein gleichgewichteter Proxy für das Marktportefeuille nicht im Einklang mit *Markowitz* (1952, 1959) und dem darauf aufbauenden *Sharpe-Lintner*-Capital-Asset-Pricing-Modell (CAPM). Daher wird hier von der Anwendung eines gleichgewichteten Marktportefeuilles abgesehen.

5.2 Renditen einzelner Aktien

Ausgangspunkt für die Erstellung einer Renditezeitreihe für den Geregelten Markt ist die Berechnung der monatlichen Renditen auf Basis der von uns erhobenen Daten. Dabei folgen wir prinzipiell der Vorgehensweise von *Stehle/Hartmond* (1991)[81]. Wir verwenden also Monatsschlusskurse und beziehen Dividenden (reguläre Dividenden und eventuell zusätzlich gezahlten Bonusdividenden), die Körperschaftsteuergutschrift, Bezugsrechte, Kapitalerhöhungen aus Gesellschaftsmitteln, Nennwertumstellungen und Kapitalherabsetzungen ein. Im Gegensatz zu *Stehle/Hartmond* (1991) verwenden wir gegebenenfalls Kurse anderer Börsen (*vgl. Abschnitt* 3) und den sogenannten rechnerischen Wert der Bezugsrechte, nicht die tatsächlichen, am Markt quotierten Bezugsrechtspreise.[82]

Ferner wird bei der Renditeberechnung die zeitliche Abfolge von Dividenden und Kapitalmaßnahmen berücksichtigt. Die Notwendigkeit hierfür kann beispielhaft anhand der M.A.X. Automation AG illustriert werden. Diese schüttete am 3. Juli 1996 eine Dividende von umgerechnet 8,18 € aus (daraus ergibt sich eine Körperschaftsteuergutschrift von 3,51 €). Im

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[80] Für wissenschaftliche Zwecke werden oftmals parallel zu den wertgewichteten auch gleichgewichtete Renditezeitreihen berechnet, wie z. B. der gleichgewichtete DAFOX oder die gleichgewichtete Daily Equal-Weighted Return with Dividend (EWRETD) Zeitreihe von CRSP. Bei modernen Renditezeitreihen wird im Unterschied zu Älteren laufend umbasiert, hier monatlich.

[81] Vgl. auch *Deutsche Börse Group* (2007c, S. 24-40) zur Indexberechnung.

[82] Durch die Einbeziehung des theoretischen Bezugsrechtswertes, welcher in Deutschland im Schnitt ca. 11 bis 12 % höher ist als der tatsächliche Kurs, wird die Rendite der Aktien etwas überschätzt. Vgl. *Röder/Dorfleitner* (2002), S. 473; *Lorenz/Röder* (1999), S. 77-78. Für den Zeitraum 1989 bis 1995 ist die durchschnittliche Unterbewertung der Bezugsrechtskurse für die Aktien des Geregelten Marktes ca. 6,1 % höher als für die Aktien des Amtlichen Marktes. Vgl. *Lorenz/Röder* (1999), S. 78. Allerdings wird selbst bei der Berechnung des CDAX der theoretische Bezugsrechtswert verwendet. Vgl. *Deutsche Börse Group* (2007c), S. 29-31.

gleichen Monat (am 29. Juli 1996) implementierte das Unternehmen eine Kapitalerhöhung aus Gesellschaftsmitteln im Verhältnis 3 zu 1 (für drei Aktien wird eine Gratisaktie ausgegeben). Auf Basis der Monatsschlusskurse von Juni 1996 (399 €) und Juli 1996 (298 €) ergibt sich für den Juli 1996 eine Rendite von $\frac{298\,€\ /0{,}75\ +\ 8{,}18\,€\ +\ 3{,}51\,€}{399\,€} - 1 = 2{,}51\ \%$. Eine fehlerhafte Auswertung der Ereignisreihenfolge führt zu einer Rendite von $\frac{(298\,€\ +\ 8{,}18\,€\ +\ 3{,}51\,€)/0{,}75}{399\,€} - 1 = 3{,}49\ \%$. Für den Fall, dass für eine Aktie zwei Ereignisse auf den gleichen Ex-Tag fallen, wird unter der Annahme, dass Dividenden vor der Implementierung von Kapitalmaßnahmen ausgeschüttet werden, erst die Kapitalmaßnahme und anschließend die Dividende ausgewertet. Analog werden vor Kapitalherabsetzungen oder Nennwertumstellungen erst Kapitalerhöhungen bereinigt.

Insgesamt wurden 18.383 monatliche Renditen (19.662 inkl. Penny Stocks) berechnet. Die Spannweite der Renditen reicht von -89,90 % bis 329,85 %.[83] Das arithmetische Mittel aller Renditen beträgt 0,93 % und die Standardabweichung 15,13 %. Die Renditen sind rechtsschief und leptokurtisch verteilt (*vgl. Abbildung 3*). Gegenüber dem Amtlichen Markt (ebenfalls ohne Penny Stocks) sind im Zeitraum Mai 1987 bis Oktober 2007 im Geregelten Markt prozentual etwas mehr Renditen größer als 31 % (2,51 % versus 1,26 %) und kleiner als -31 % (1,13 % versus 0,52 %). Hervorzuheben ist der hohe Anteil an Renditen im Bereich von -1 bis 1 % (Renditecluster 0 in *Abbildung 3*) von 16,20 % im Amtlichen Markt und 15,04 % im Geregelten Markt, welcher auf die geringe Liquidität kleinerer Aktiengesellschaften zurückzuführen ist.[84] Der Anteil der Nullrenditen (Renditen im Bereich von -0,01 % bis 0,01 %) ist im Geregelten Markt etwas höher als im Amtlichen Markt (6,70 % versus 4,70 %). Die Renditeverteilung für den Amtlichen Markt weist gegenüber dem Geregelten Markt eine höhere Kurtosis auf. Die Standardabweichung wiederum ist im Geregelten Markt höher. Der Mittelwert der Renditen ist für beide Segmente ähnlich. Die Nullhypothese, dass die Aktienrenditen normal verteilt sind, kann mit dem Jarque-Bera-Test für beide Marktsegmente abgelehnt werden.

[Abbildung 3]

5.3 Monatliche Durchschnittsrenditen

Bis heute gibt es keine durchgehende Renditezeitreihen bzw. Indizes für die einzelnen Segmente der Frankfurter Aktienbörse (abgesehen vom Neuen Markt) bzw. für Gesamtheiten, die aus mehreren Segmenten bestehen (*vgl. auch Abschnitt 5.1*). Die Situation für die anderen deutschen Börsen ist allerdings noch schlechter. Insbesondere existiert bisher keine

[83] Die höchste Rendite von 700 % erzielte jedoch die OAR Consulting AG am 31.07.2003, deren Kurs zu diesem Zeitpunkt jedoch deutlich unter 1,00 € lag. *Stehle/Hartmond* (1991, S. 383) stellen für die Aktienrenditen des Amtlichen Marktes fest, dass die Renditen von 1955 bis 1988 im Bereich von -80 % bis 380 % liegen.

[84] Dies liegt daran, dass sich der Börsenhandel zumeist auf die wenigen relativ großen Aktiengesellschaften konzentriert. *Baums* (1997, S. 13) führt hierzu an: „[N]ahezu 100 % des durchschnittlichen täglichen Umsatzvolumens von rd. DM 4,9 Milliarden werden im amtlichen Handel erzielt; an einzelnen Börsentagen kommen bei fast der Hälfte aller am Geregelten Markt gehandelten Werte keine Umsätze zustande."

Renditezeitreihe für den Geregelten Markt.[85] Wir berechnen auf Basis der monatlichen Renditen der einzelnen Unternehmen marktwert- und gleichgewichtete Durchschnittsrenditen aller Unternehmen des Geregelten Marktes. In wissenschaftlichen Studien, insbesondere in IPO-Studien, werden schon länger neben gleich- auch marktwertgewichtete Portefeuillerenditen herangezogen.[86] Bei gleichgewichteter Betrachtung hat ein „kleines" Unternehmen grundsätzlich den gleichen Einfluss auf die Portefeuillerenditen wie ein „großes" Unternehmen, obwohl letzteres aus Investorensicht, aufgrund der höheren Marktkapitalisierung, höher gewichtet werden sollte. Problematisch ist auch, dass bei kleineren Unternehmen hohe Kursänderungen („Ausreißer") tendenziell häufiger vorkommen als bei größeren Unternehmen. Ausreißer unter den kleinen Unternehmen beeinflussen gleichgewichtete Portefeuillerenditen stärker als marktwertgewichtete.[87] Bei der Berechnung gleichgewichteter Renditen stellen insbesondere Penny Stocks ein weiteres Problem dar. Bei Penny Stocks treten extreme Kursänderungen (beispielsweise von ±100 %) sehr häufig auf. Hierdurch werden gleichgewichtete Portefeuillerenditen, insbesondere bei einer hohen Anzahl von Penny Stocks im betrachteten Portefeuille, stark beeinflusst.[88] Daher beziehen wir bei der Berechnung gleichgewichteter Durchschnittsrenditen für den Geregelten Markt Penny Stocks nicht ein. Generell ist zu berücksichtigen, dass die meisten Unternehmen des Geregelten Marktes im Vergleich zu denen des Amtlichen Marktes hinsichtlich ihrer Marktkapitalisierung sehr klein sind, die Streuung der Unternehmensgrößen also deutlich geringer ist. Dennoch könnten Unterschiede zwischen den gleich- und marktwertgewichteten Portefeuillerenditen des Geregelten Marktes unter Umständen auf einen Size-Effekt innerhalb des Marktsegments hinweisen.

Die durchschnittliche jährliche marktwertgewichtete Rendite für den Geregelten Markt liegt im Zeitraum Juli 1988 bis Oktober 2007 mit 8,1 % (geometrisches Mittel) bzw. 9,2 % (arithmetisches Mittel) deutlich unter der des Amtlichen Marktes mit 11,2 % bzw. 12,9 % (*vgl. Tabelle 8*). *Abbildung 4* zeigt, dass sich der Geregelte Markt und der Amtliche Markt bis Ende 1993 ähnlich entwickelten. An den enormen Kursanstiegen zwischen 1994 und 2000, also vor dem Platzen der „Dot-Com-Blase", nahmen die Aktien des Geregelten Marktes nicht teil. Zwischen Februar 2000 und März 2003 verloren die Unternehmen des Amtlichen Marktes fast 58,0 % an Wert (von 765,90 Punkte auf 321,56 Punkte) während die Unternehmen des Geregelten Marktes lediglich 41,5 % an Wert verloren (von 239,68 Punkte auf 140,12 Punkte). Zwischen April 2003 und Oktober 2007 performten die Unternehmen des Geregelten Marktes deutlich besser als die des Amtlichen Marktes. Bis zum 31. Dezember 2007 erreichte die AMX-Zeitreihe 1034,87 Punkte. Die Indexzeitreihe für den Geregelten Markt erreichte nur 559,89 Punkte. Für den

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85 *Baums* (1995, S. 15) schlug bereits 1995 die Berechnung eines Indizes für den Geregelten Markt vor, wir sind u. E. die ersten die seinen Vorschlag aufgreifen.

86 Vgl. *Loughran/Ritter* (1995); *Stehle/Ehrhardt/Przyborowsky* (2000); *Purnanandam/Swaminathan* (2004).

87 „Kleine" Ausreißer haben nur einen geringen Einfluss auf marktwertgewichtete Portefeuillerenditen, diese werden von besonders „großen" Unternehmen dominiert.

88 Aufgrund ihrer Eigenschaften sind Penny Stocks auch besonders anfällig für Kursmanipulationen. Hinzu kommt, dass derartige Aktien oft eine sehr geringe Liquidität aufweisen und ein Handel nur selten stattfindet.

Zeitraum von April 2003 bis Oktober 2007 ergibt sich für den Geregelten Markt eine jährliche durchschnittliche Änderungsrate von 31,33 % und für den Amtliche Markt von 26,58 %.

[Abbildung 4]

5.4 Risikoadjustierte Durchschnittsrenditen für den Gesamtzeitraum

Ein Schwachpunkt des bisherigen Performancevergleichs ist die fehlende Risikobereinigung. Hinzu kommt, dass der Renditeunterschied zwischen dem Geregelten Markt und dem Amtlichen Markt statistisch nicht signifikant ist. Die Nullhypothese, dass die monatliche Durchschnittsrendite des Geregelten Marktes gleich der des Amtlichen Marktes ist, kann mit einem einfachem t-Test nicht abgelehnt werden. Aus diesem Grund wird ein mächtigeres Testverfahren herangezogen, wobei implizit unterstellt wird, dass das CAPM für den deutschen Kapitalmarkt gültig ist. Für den Zeitraum Juni 1987 bis Oktober 2007 wird folgendes Regressionsmodell nach *Black/Jensen/Scholes* (BJS, 1972) geschätzt:

$$r_{p,t} - r_{f,t} = \alpha_p + \beta_p \left(r_{m,t} - r_{f,t} \right) + \varepsilon_{p,t} \tag{F1}$$

wobei

$r_{p,t}$ – die Portefeuillerendite der Aktien des Geregelten Marktes für Periode t,
$r_{f,t}$ – der risikofreie Zinssatz für die Periode t,
α_p – Jensen's Alpha für den Geregelten Markt,
β_p – das Beta des Portefeuilles aller im Geregelten Markt notierten Aktien,
$r_{m,t}$ – die Portefeuillerendite der Aktien des Amtlichen Marktes für Periode t
$\varepsilon_{p,t}$ – der zufällig verteilte Fehlerterm für die Periode t.

Das Hauptaugenmerk bei den hier durchgeführten empirischen Untersuchungen liegt auf dem von *Jensen* (1968) eingeführten Performancemaß, α_p (*Jensens* Alpha). Ein positives Alpha signalisiert eine positive Abweichung von der Wertpapierkennlinie, also eine risikoadjustierte Überrendite im Vergleich zum Benchmark. Allerdings sind Ergebnisse auf Basis von *Gleichung F1* unter Verwendung monatlicher Renditedaten aufgrund der oben dargestellten Illiquidität der Aktien des Geregelten Marktes und der sich daraus ergebenden Autokorrelation der Renditen durchaus kritisch zu betrachten. *Scholes/Williams* (1977), *Dimson* (1979) und *Roll* (1981) zeigen, dass die Einbeziehung illiquider Aktien zu einer Verzerrung der geschätzten OLS-Regressionskoeffizienten führt. *Scholes/Williams* (1977, S. 316) zeigen unter anderem, dass das Marktmodell bei Zugrundelegung kurzfristiger Renditeintervalle die Alphas unregelmäßig gehandelter Aktien überschätzt und deren Betas unterschätzt.

Das Illiquiditätsproblem kann durch die Betrachtung vierteljährlicher bzw. jährlicher Rendite-intervalle umgangen werden. Allerdings existierte der Geregelte Markt nur circa 20 Jahre, so dass für die Untersuchung jährlicher Renditedaten nur wenige Beobachtungen vorliegen. Eine Alternative stellt das von *Dimson* (1979) vorgeschlagene Verfahren zur Schätzung aggregierter Betas dar. Bei diesem Verfahren besteht die Möglichkeit neben der Marktüberschussrendite für den Monat t auch die Überschussrenditen des Marktes für die Vormonate gegenüber dem risikofreien Zinssatz für den Monat t (Lags) einzubeziehen. Der Test gemäß *Gleichung F1* kann unter Berücksichtigung der Ergebnisse von *Dimson* (1979) wie folgt modifiziert werden (BJS, adj.):

$$r_{p,t} - r_{f,t} = \alpha_p + \sum_{l=0}^{Lags} \beta_{p,l} \left(r_{m,t-l} - r_{f,t} \right) + \varepsilon_{p,t} \tag{F2}$$

Das systematische Risiko β_p ergibt sich aus der Summe der in *Gleichung F2* geschätzten Beta-koeffizienten $\beta_{p,l}$. Wir verwenden jeweils ein Lag bei monatlicher sowie vierteljährlicher Betrachtungsweise. Die Durchschnittsrenditen des Geregelten Marktes werden durch marktwert- und gleichgewichtete Portefeuille-Renditen bestimmt.[89] Als risikolose Zinssätze werden den Beobachtungsintervallen entsprechende Geldmarktsätze des Frankfurter Geldmarktes verwendet.[90]

Die in *Tabelle 4* auf Basis von *Gleichung F1* geschätzten annualisierten Alpha-Koeffizienten sind unabhängig vom Anlagehorizont und zugrunde liegendem Index statistisch nicht signifikant von null verschieden. Die Nullhypothese, dass das CAPM im Untersuchungszeitraum die Renditen des Geregelten Marktes erklärt, kann nicht abgelehnt werden. Im Vergleich zum Amtlichen Markt weisen die Aktien des Geregelten Marktes ein deutlich geringeres systematisches Risiko auf.[91] Der mit zunehmenden Beobachtungsintervall einhergehende deutliche Anstieg der OLS-Betas ist auf die oben diskutierte geringe Liquidität der Aktien des Geregelten Marktes und der damit einhergehenden Autokorrelation der Renditen zurückzuführen. Die *Dimson*-Betas sind jeweils deutlich höher als die entsprechenden OLS-Betas. Die Differenz zwischen den OLS-Betas und den *Dimson*-Betas beträgt im Schnitt circa 0,19. Die Betas, $\beta_{p,1}$, für die um eine Periode verschobene Überschussrendite (1 Lag) sind durchgehend auf dem 1 %-Signifikanzniveau statistisch signifikant von Null verschieden (nicht dargestellt). Dies impliziert, dass für die monatlichen und vierteljährlichen Beobachtungs-intervalle die Aussagekraft der OLS-Regressionskoeffizienten eingeschränkt ist. Wir gehen davon aus, dass die Regressionskoeffizienten auf Basis jährlicher Beobachtungsintervalle den geringsten Schätzfehler aufweisen. Die Differenz zwischen den marktwertgewichteten Alphas (meist negativ) und den gleichgewichteten Alphas (durchgehend positiv) deuten auf einen Size-Effekt innerhalb des Geregelten Marktes hin (*vgl. Tabelle 4*).[92] Demnach boten die kleinsten

[89] Die Portefeuillerenditen sind autokorreliert, wodurch bei Betrachtung kurzer Beobachtungsintervalle das Risiko der Aktien unterschätzt wird. Vgl. *Roll* (1981), S. 879 und S. 884. Die Annahme einer Normalverteilung der Portefeuillerenditen kann auf Basis des *Jarque-Bera*-Tests abgelehnt werden.

[90] Für die Regression auf Basis monatlicher Daten wird der durchschnittliche Monatsgeldzinssatz (SU0104), für die vierteljährlichen Renditen der Dreimonatsgeldzinssatz (SU0107) und für die jährlichen Renditen der Zwölfmonatsgeldzinssatz (SU0253) herangezogen. Die genannten Zinssätze stehen auf der Webseite der Bundesbank (URL: www.bundesbank.de) zur Verfügung.

[91] *Stehle* (1997, S. 85) stellte bereits fest, dass in Deutschland „kleine" Aktien im Schnitt Betas kleiner als eins besitzen, in den USA haben sie im Schnitt Betas größer als eins.

[92] Die positiven gleichgewichteten Alphas in *Tabelle 4* könnten auf einen positiven Size-Effekt gegenüber dem Amtlichen Markt hindeuten, da der Geregelte Markt zumeist Aktien mit relativ geringer Marktkapitalisierung enthielt. Demnach schnitten die einzelnen Aktien des Geregelten Marktes gegenüber dem Amtlichen Markt etwas besser ab.

Aktien eine etwas höhere risikoadjustierte Rendite als die etwas größeren, aber dennoch kleinen Aktien des Geregelten Marktes.

[Tabelle 4]

Die in *Tabelle 5* dargestellten Regressionskoeffizienten auf Basis jährlicher Überrenditen für die oben beschriebenen Size-Portefeuilles (*vgl. Tabelle 2*) zeigen, dass die kleineren Aktien des Geregelten Marktes gegenüber den größten Aktien (Top-5%) eine höhere risikoadjustierte Rendite aufweisen. Im Vergleich zu den anderen Size-Portefeuilles sind die Alphas für das Portefeuille der größten Aktien, Top-5%, am geringsten (*vgl. Tabelle 5*). Die Alphas für das Portefeuille D02 sind ebenfalls stark negativ. Hinzu kommt, dass die Alphas für beide Portefeuilles, D02 und Top-5%, statistisch signifikant von Null verschieden sind. Die marktwertmäßig kleinsten Aktien des Geregelten Marktes (Portefeuille D01) schnitten hingegen am besten ab (Alpha von 4,09 % bzw. 1,06 %). Diese Ergebnisse stützen zum Teil die Hypothese eines regulären Size-Effektes innerhalb des Geregelten Marktes im Zeitraum von 1988 bis 2007.[93] Allerdings ist anzumerken, dass insbesondere die Ergebnisse des BJS-Tests auf Basis marktwertgewichteter Überrenditen für die vier Size-Portefeuilles durch die geringe Anzahl von Unternehmen pro Portefeuille zum Teil erheblich durch einzelne Unternehmen dominiert werden und somit nicht aussagekräftig sind. So werden beispielsweise die marktwertgewichteten Renditen des Size-Portefeuilles D01 im Zeitraum von Januar 1997 bis Juli 1998 durch die Baader Wertpapierhandelsbank AG dominiert.[94] In diesem Zeitraum betrug die monatliche Durchschnittsrendite des Unternehmens circa 39,56 %. Die Marktkapitalisierung stieg von circa € 9 Mio. auf € 723 Mio. (nominal). Infolge derartiger Fälle, ergibt sich für den Gesamtzeitraum eine Differenz von 0,92 zwischen dem marktwert- und gleichgewichteten Betas für das Size-Portefeuilles D01 (*vgl. Tabelle 5*).

5.5 Risikoadjustierte Durchschnittrenditen für Subperioden

Die grafische Darstellung des Zusammenhangs zwischen den jährlichen marktwertgewichteten Überrenditen für den Amtlichen Markt und den Geregelten Markt zeigt, dass ab 2002 (Periode von Juli 2001 bis Juni 2002) mehr Punkte als erwartet oberhalb der Regressionsgerade liegen (*vgl.* Abbildung 5). Für den Zeitraum von Juli 1988 bis Juni 2001 beträgt die durchschnittliche Überrendite des Geregelten Marktes gegenüber dem Amtlichen Markt -8,56 %, von Juli 2001 bis Juni 2007 hingegen 9,73 %. In diesem Zusammenhang ist es fraglich, ob weiterhin von einer zeitlichen Stabilität der Regressionskoeffizienten ausgegangen werden kann. Zur genaueren Untersuchung dieser Fragestellung unterteilen wir den Gesamtzeitraum in vier fünfjährige Subperioden, wobei ausschließlich die Aktien der Size-Portefeuilles D01 bis D03 einbezogen werden, nicht jedoch die größten 5 % der Aktien des Geregelten Marktes (Top-5%).

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[93] Die Untersuchungen von *Brückner et al.* (2012) deuten für den Amtlichen Markt auf einen Reverse-Size-Effekt zwischen 1990-2007 hin. Auf die genauere Untersuchung des Size-Effektes innerhalb des Geregelten Marktes mittels Querschnittsregressionen nach *Fama/MacBeth* wird hier jedoch verzichtet.

[94] Die Baader Wertpapierhandelsbank AG ging am 01.08.1994 im Geregelten Markt im Rahmen eines IPOs an die Börse. Am 22.09.1998 wechselte das Unternehmen in den Amtlichen Markt.

[Abbildung 5]

Die in *Panel A von Tabelle 6* dargestellten marktwert- und gleichgewichteten Alphas für die vier Subperioden variieren deutlich im Gesamtzeitraum. In den ersten drei Subperioden sind die Alphas durchgehend negativ und in der zweiten Periode von Juli 1993 bis Juni 1998 zum Teil sogar statistisch signifikant. In der vierten Periode hingegen sind die Alphas durchgehend positiv, allerdings nicht statistisch signifikant. Die in *Tabelle 4* dargestellten Alphas sind größtenteils auf die hohen positiven Alphas in der letzten Subperiode von Juli 2003 bis Oktober 2007 zurückzuführen. Die OLS-Betas sind für alle vier Subperioden deutlich kleiner als eins.[95] Zusätzlich wird beobachtet, dass die OLS-Betas im Zeitablauf abnehmen. Die Dimson-Betas sind in *Panel A* zumeist deutlich größer als die OLS-Betas, näher an eins und für die zweite Periode sogar deutlich größer als eins. Die Ergebnisse veranschaulichen, dass selbst die Betrachtung vierteljährliche Renditedaten zu einer deutlichen Unterschätzung des systematischen Risikos und damit einhergehenden Überschätzung der risikoadjustierten Renditen, gemessen durch *Jensens* Alpha, führen kann. So unterscheiden sich bspw. die Alphas und Betas in der vierten Subperiode bei gleichgewichteter Betrachtung erheblich. Gemäß *Gleichung F1* schätzen wir ein Alpha von 15,00 % und ein Beta von 0,44, gemäß *Gleichung F2* hingegen ein Alpha von 4,11 % und ein Beta von 0,89. Ferner kann die Nullhypothese, dass sich die Regressionskoeffizienten der dritten und vierten Subperioden nicht voneinander unterscheiden, auf Basis eines *Chow*-Tests auf dem 1 %-Niveau für monatliche Renditedaten (unter Verwendung von OLS-Betas) abgelehnt werden. Auf weitere Strukturbrüche zwichen den andern Teilperioden gibt es keine eindeutigen Hinweise.

[Tabelle 6]

5.6 Der Einfluss von IPOs auf die Durchschnittsrendite

In Untersuchungen zum Market-Microstructure-Effekt für den amerikanischen Kapitalmarkt führte *Loughran* (1992, S. 253) circa 60 % der Renditedifferenz zwischen der NYSE und der NASDAQ von circa 6 % auf die IPO-Underperformance der NASDAQ-Unternehmen zurück. Die Ausprägung der Alphas in Panel A der *Tabelle 6*, könnte demnach zum Teil auf eine Underperformance der IPOs im Geregelten Markt zurückzuführen sein. Für diese Hypothese spricht, dass der prozentuale Anteil der IPOs im Geregelten Markt höher ist als im Amtlichen Markt (vgl. *Abschnitt 4.1*). Hinzu kommt, dass insbesondere in der ersten Periode nur wenige Aktien im Geregelten Markt notierten. Ferner entfällt ein Großteil der IPOs auf das Size-Portefeuilles D03 (*vgl. Tabelle 2*). Dementsprechend war der Einfluss von Börsenneuzugängen, insbesondere auf die marktwertmäßige Performance des Geregelten Marktes sehr stark.[96] Dies ist relevant, da verschiedene IPO-Studien für den deutschen Aktienmarkt zeigen, dass IPOs

95 Andere Autoren beobachten ebenfalls Betas kleiner als eins für Aktienportefeuilles mit niedrigem Marktwert. *Ziegler/Schröder* (2007, S. 373) für 1968 bis 1995 im Bereich von 0,470 bis 0,742 (Mittelwert: 0,578) und *Schulz/Stehle* (2002, S. 27) für 1968 bis 1993 im Bereich von 0,439 bis 0,712 (Mittelwert: 0,570).

96 Insgesamt gingen 129 von 210 (61,4 %) Aktien in diesem Segment an die Börse (*vgl. Kapitel 4.1*).

zwar kurzfristig eine positive, langfristig jedoch eine negative abnormale Rendite aufweisen.[97] *Neuhaus/Schremper* (2003, S. 454) beobachteten, dass die langfristige IPO-Underperformance zwischen dem 1. Januar 1995 und dem 31. Juli 2000 im Geregelten Markt gegenüber dem Amtlichen Markt deutlich stärker ausgeprägt war (-57,19 % versus -31,76 % nach drei Jahren).[98]

Zur Prüfung dieser Hypothese versuchen wir die Auswirkungen eines potenziellen IPO-Effekt auf die marktwert- und gleichgewichteten Renditen für den Geregelten Markt zu minimieren. IPOs gehen dabei erst fünf Jahre nach ihrem Börsengang in die Berechnung der Durchschnittsrenditen ein. Durch diese Vorgehensweise werden unter anderm Unternehmen wie die oben genannte Baader Wertpapierhandelsbank AG komplett ausgeschlossen. Die Ergebnisse dieser Untersuchung werden in Panel B der Tabelle 6 und Tabelle 7 dargestellt. Im Vergleich zu Tabelle 4 ergeben sich in Tabelle 7 nach Ausschluss der IPOs für den Gesamtzeitraum von Juli 1988 bis Oktober 2007 unabhängig von der Gewichtung (gleich- und marktwertgewichtet) und dem Renditeintervall (monatlich, vierteljährlich und jährlich) immer positive Alphas. Allerdings sind auch hier die Alphas nicht statistisch signifikant.

Im direkten Vergleich der Ergebnisse in Panel A und B der Tabelle 6 ergeben sich bei Nichteinbeziehung der IPOs in der Regel auch etwas höhere Alphas in den vier Subperioden. Insbesondere sind die Alphas in der zweiten Subperiode nicht mehr statistisch signifikant. Die Alphas nach *Gleichung F2* sind in allen Subperioden nicht statistisch signifikant. Anzumerken ist, dass in allen vier Subperioden die etwas höheren Alphas mit einem etwas geringerem systematischen Risiko einhergehen, sodass die höheren Alphas möglicherweise auf einen Skalierungseffekt zurückzuführen sind. Die Ursache für die positive Ausprägung der Alphas in der vierten Subperiode von durchschnittlich 15,25 % könnte verschiedene Ursachen haben. Unter anderem könnte die Einführung der Teilbereiche General und Prime Standard, in Zusammenhang mit der fortgeschrittenen Annäherung an den Amtlichen Markt und der Novellierung des Börsengesetztes die Nachfrage nach diesen Aktien erhöht haben. Ferner könnte die Performance in der vierten Periode auf einen starken Size-Effekt zurückzuführen sein. Demnach würden die kleinen Aktien des Geregelten Marktes gegenüber den großen Aktien des Amtlichen Marktes von 2003-2007 eine höhere risikoadjustierte Rendite aufweisen. Die Ergebnisse für die Jahre von 1988 bis 2003 könnten analog zum Teil auf einen Reverse-Size-Effekt zurückzuführen sein.

Bei der Interpretation der Regressionsergebnisse ist zu beachten, dass die adjustierten Bestimmtheitsmaße für den letzten Untersuchungszeitraum relativ gering sind. Demnach könnte es

[97] Diese Aussage bezieht sich auf verschiedene IPO-Studien für den deutschen Kapitalmarkt wie *Stehle/Ehrhardt/Przyborowsky* (2000); *Neuhaus/Schremper* (2003); *Schenek* (2006).

[98] Die Aussage von *Neuhaus/Schremper* für den Geregelten Markt basiert auf eine Stichprobe von lediglich 23 IPOs. Hinzu kommt, dass mit dem CDAX bereinigt wurde. Der CDAX wird jedoch durch dir großen Unternehmen des Amtlichen Marktes und des Neuen Marktes dominiert. Somit sind die Ergebnisse aus unserer Sicht für den Geregelten Markt nur bedingt aussagekräftig.

neben der Marktrendite weitere Faktoren geben, welche die Renditen der betrachteten Portefeuilles erklären. Hierbei könnten, wie von *Schulz/Stehle* (2002), *Ziegler/Schröder* (2007) und zuletzt *Brückner/Lehmann/Stehle* (2012) gezeigt, Size- und Buchwert-Marktwert-Faktoren (bzw. entsprechenden Unternehmenscharakteristika) eine entscheidende Rolle spielen.

6 Zusammenfassung

Dieser Aufsatz ergänzt die bisherige Literatur zu den institutionellen Rahmenbedingungen und bietet eine sehr detaillierte Darstellung der ökonomischen Aspekte des Geregelten Marktes in Frankfurt. Hierzu erstellten wir speziell für dieses Segment eine Datenbank, anhand derer wir anschließend gleich- und marktwertgewichtete Portefeuillerenditen entsprechend der heute üblichen Vorgehensweise berechnen. Die drei wichtigsten Ergebnisse dieser Studie sind:

- Im Hinblick auf die Zahl der Börseneinführungen (in Prozent der jeweils notierten Gesellschaften) wurde der Amtliche Markt übertroffen. Die Anzahl der zum Jahresanfang notierten Aktien wurde ab 1990 im Schnitt um 6,93 % pro Jahr durch IPOs erhöht, im Amtlichen Markt nur um 2,34 %.
- Trotz des „Aderlasses“ durch Aufsteiger in den Amtlichen Markt (im Schnitt 2,34 % der zum Jahresanfang notierten Aktien zwischen 1990 und 2007) konnte anders als im Amtlichen Markt eine fast stetige Zunahme der Zahl der notierten inländischen Aktien verzeichnet werden.
- Bei Zugrundelegung des Sharpe-Lintner-Modells ergibt sich, dass die Aktien des Geregelten Marktes im Schnitt etwas besser abschnitten, als die Aktien des Amtlichen Marktes. Dieses Ergebnis ist allerdings sensitiv im Hinblick auf die Vorgehensweise.

Weitere wichtige Ergebnisse sind:

- Im Vergleich zum Amtlichen Markt in Frankfurt ist der Anteil der Dividenden ausschüttenden Gesellschaften eher geringer, Kapitalerhöhungen, Kapitalerhöhungen aus Gesellschaftsmitteln und Nennwertumstellungen erfolgten ähnlich häufig, Kapitalherabsetzungen traten hingegen prozentual etwas öfter auf.
- Der Anteil der Penny-Stocks zum 1. Januar 2003 (23,23 %) ist beträchtlich höher als im Amtlichen Markt (5,52 %). Extreme Kursbewegungen bei einzelnen Aktien treten im Geregelten Markt prozentual etwas häufiger auf als im Amtlichen Markt, ebenso monatliche Renditen von bzw. nahe null.
- Im Zeitraum von Januar 1988 bis Oktober 2007 betrug die durchschnittliche jährliche marktwertgewichtete Rendite 10,96 % (arithmetisches Mittel) bzw. 8,99 % (geometrisches Mittel). Die entsprechenden Werte für den Amtlichen Markt (AMX-Zeitreihe) sind 14,17 % bzw. 12,02 %.
- Wie bei größenmäßig vergleichbaren Aktien des Amtlichen Marktes ist das nicht diversifizierbare Risiko eher niedrig.

Insgesamt beurteilen wir den Geregelten Markt in Frankfurt im Rahmen der beschriebenen institutionellen Gegebenheiten sehr positiv. Insbesondere hinsichtlich der Primärmarkteigenschaften des Geregelten Marktes kommen wir zu einer beträchtlich besseren ex post Beurteilung als die Beiträge, die bisher in der wissenschaftlichen Literatur und in der Finanzpresse erschienen sind. Beispielsweise schreiben *Burghof/Hunger* (2003, S. 1), dass die Marktsegmentierung im Vorfeld des Neuen Marktes nicht ausreichend war, um deutsche Unternehmen mit Eigenkapital zu versorgen. Wir hoffen, dass unsere Untersuchungen helfen, die deutschen Börsen in Zukunft noch effizienter zu gestalten.

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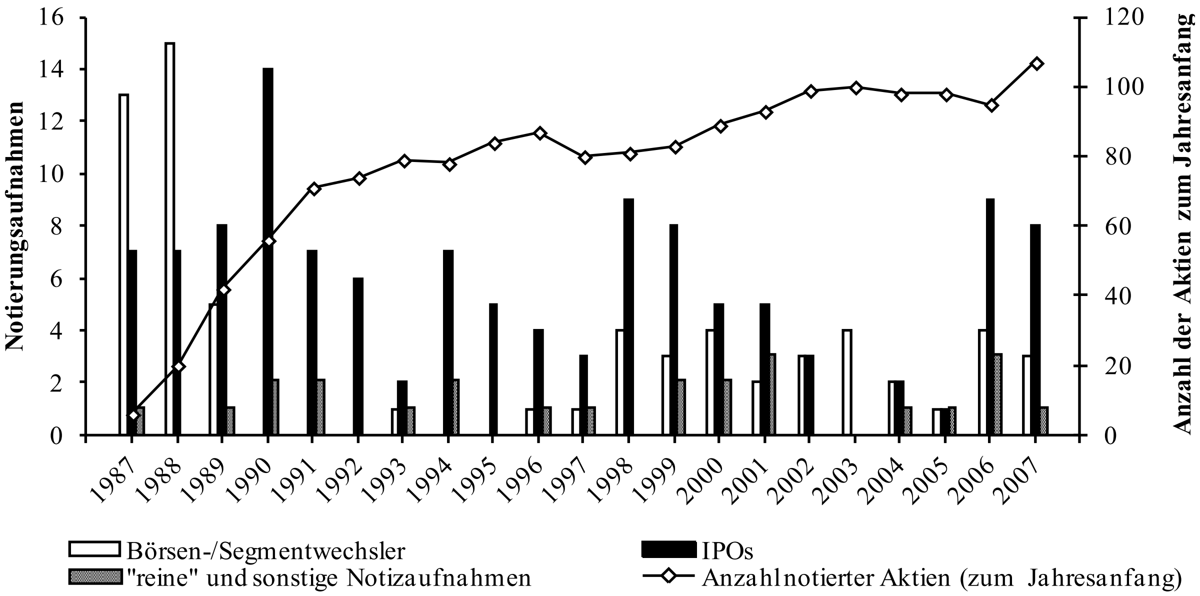
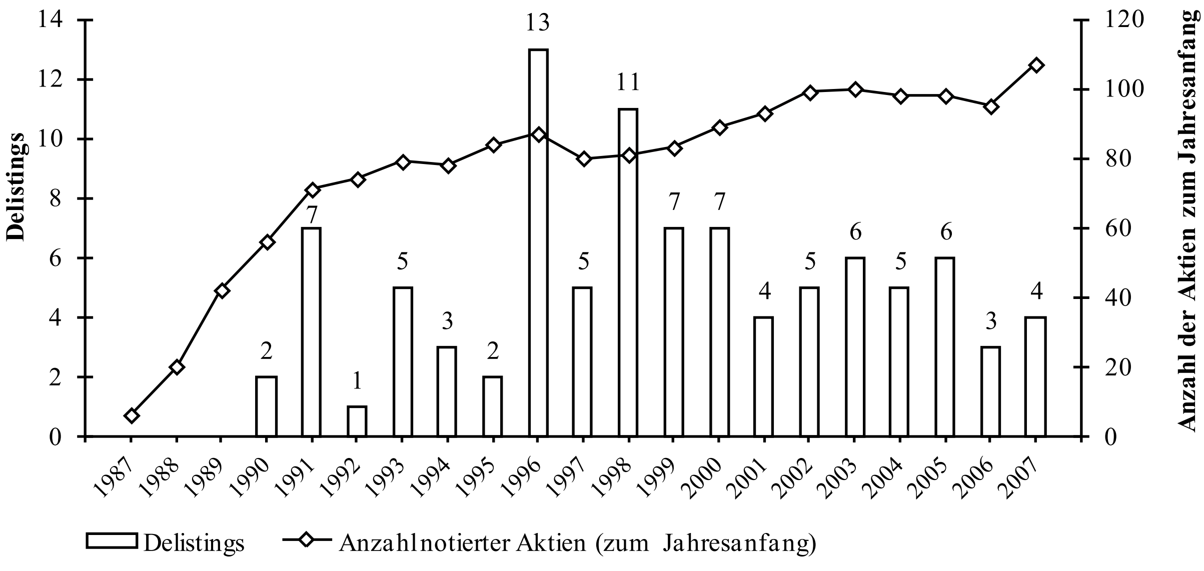
Anhang: Abbildungen und Tabellen

Abbildung 1: Zugänge zum Geregelten Markt in Frankfurt, 1987-2007.



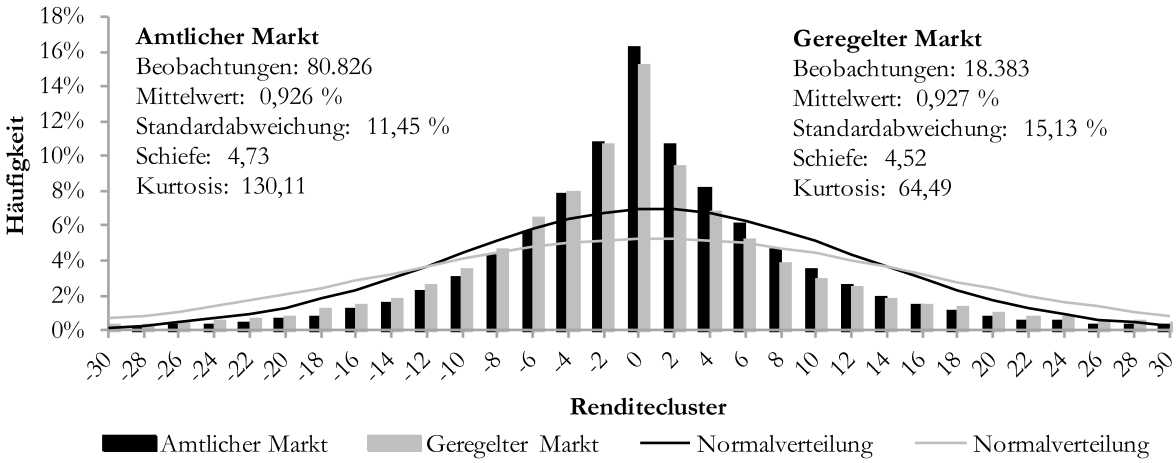
Die Abbildung zeigt die jährliche Anzahl der Zugänge von Aktien zum Geregelten Markt in Frankfurt infolge von Börsen-/Segmentwechseln (66), IPOs (120) sowie „reinen“ und sonstigen Notizaufnahmen (24). Bei der letzten Gruppe handelt es sich um neun „reine“ Notizaufnahmen (ohne begleitende Kapitalerhöhung), 13 Notizaufnahmen einer weiteren Aktiengattung und zwei Zugänge infolge von Fusionen. Die Zugänge aus dem Neuen Markt werden nicht berücksichtigt.

Abbildung 2: Delistings im Geregelten Markt in Frankfurt pro Jahr, 1987-2007.



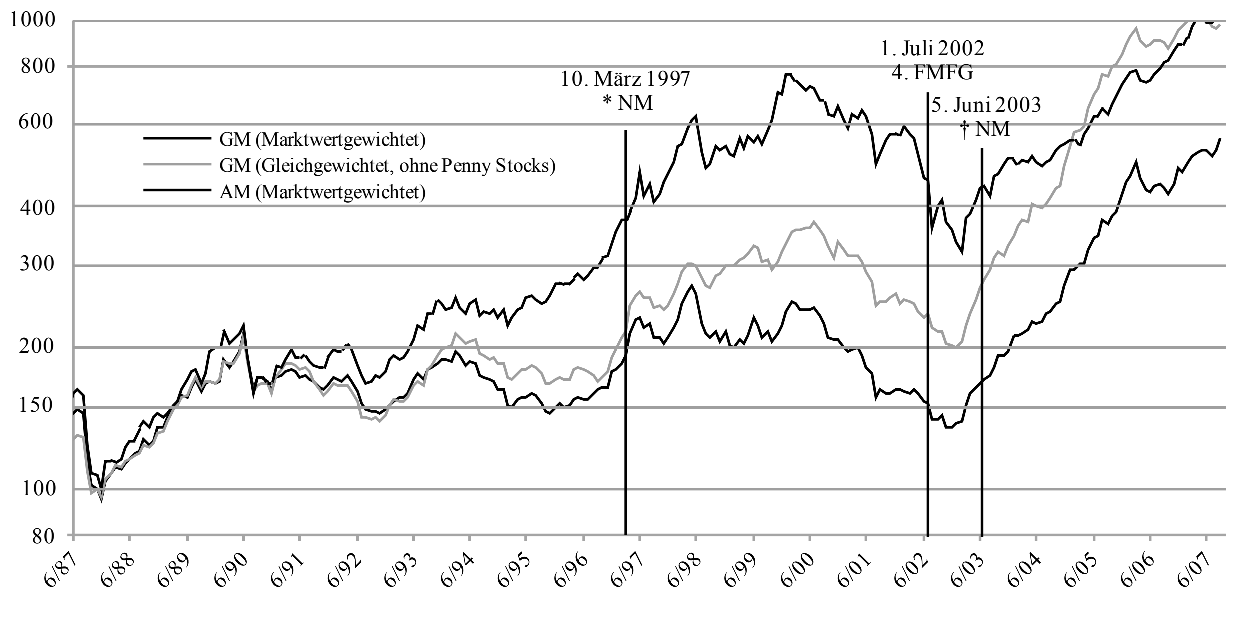
Die Abbildung zeigt die jährliche Anzahl der Delistings von Aktien im Geregelten Markt in Frankfurt. Delistings von Aktien, die zuvor im Neuen Markt notierten werden nicht berücksichtigt

Abbildung 3: Verteilung der monatlichen Renditen im Amtlichen Markt und Geregelten Markt in Frankfurt, 5/1987-10/2007.



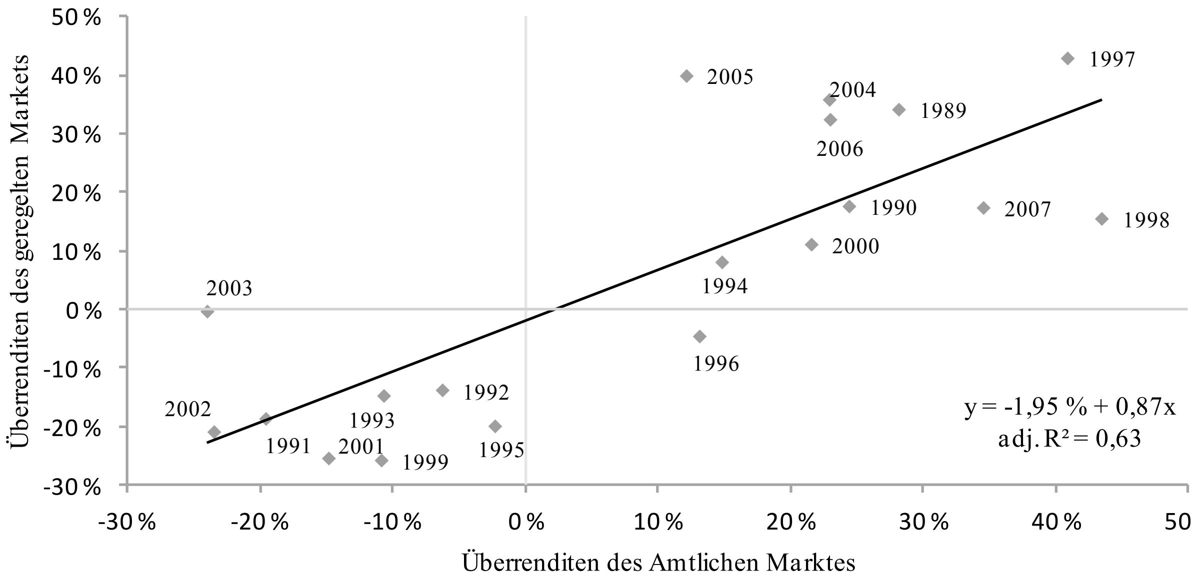
Die Abbildung zeigt die Verteilung der monatlichen Renditen der im Amtlichen Markt und im Geregelten Markt notierten Aktien für den Zeitraum Mai 1987 bis Oktober 2007 (ohne Penny Stocks). Es werden lediglich die Renditen im Bereich von -31 % (Cluster -30) bis +31 % (Cluster 30) dargestellt, welche 98,22 % (AM) bzw. 96,36 % (GM) der jeweiligen Renditen ausmachen. Die Clustergrenzen ergeben sich aus der Clusternummer ±1.

Abbildung 4: Performance des Geregelten Marktes im Vergleich zum Amtlichen Markt in Frankfurt.



Die Abbildung zeigt die Performance der Aktien des Geregelten Marktes in Frankfurt im Vergleich zum Amtlichen Markt in Frankfurt für den Zeitraum Juni 1987 bis Oktober 2007 (logarithmische Skalierung). Die Performance des Geregelten Marktes wird durch einen marktwertgewichteten und gleichgewichteten (ohne Penny Stocks) Performanceindex abgebildet. Für den Amtlichen Markt wird ein marktwertgewichteter Performanceindex herangezogen.

Abbildung 5: Regressionsgerade auf Basis jährlicher marktwertgewichteter Überrenditedaten für den Amtlichen Markt und Geregelten Markt in Frankfurt, 7/1988-6/2007.



Die Abbildung zeigt die geschätzte Regressionsgerade für die jährlichen marktwertgewichteten Überrenditen des Geregelten Marktes (abhängige Variable) gegenüber den Überrenditen des Amtlichen Marktes (unabhängige Variable) in Frankfurt. Die jährlichen Renditen werden jeweils durch das geometrische Mittel der monatlichen Renditen im Zeitraum von Juli im Jahr t-1 bis Juni im Jahr t geschätzt (inkl. Körperschaftsteuergutschrift). Der risikofreie Zinssatz wird durch die Geldmarktsätze am Frankfurter Bankplatz (Zwölfmonatsgeld, Zeitreihe: SU0253) bestimmt. Die Regressionskoeffizienten entsprechen denen in Tabelle 3.

Tabelle 1: Vergleich des Amtlichen Marktes und des Geregelten Marktes in Frankfurt in Hinblick auf die Anzahl der Aktien, IPOs, Dividendenzahlungen und Kapitalmaßnahmen im Zeitraum von Mai 1987 bis Oktober 2007.

	Amtlicher Markt Frankfurt													Geregelter Markt Frankfurt														
Jahr	Anzahl notierter Aktien	Anzahl Penny Stocks	IPOs	Dividendenausschüttungen	in Prozent	Kapitalerhöhungen mit Bezugsrecht	in Prozent	Kapitalerhöhungen aus Gesellschaftsmitteln	in Prozent	Nennwertumstellungen	in Prozent	Kapitalherabsetzungen	in Prozent	Anzahl notierter Aktien	Anzahl Penny Stocks	Zugänge (insgesamt)	IPOs	Abgänge (vor 31.10.2007)	Dividendenausschüttungen	in Prozent	Kapitalerhöhungen mit Bezugsrecht	in Prozent	Kapitalerhöhungen aus Gesellschaftsmitteln	in Prozent	Nennwertumstellungen	in Prozent	Kapitalherabsetzungen	in Prozent
1987	**250**		5	194	75,8	19	7,4	9	3,5	1	0,4	3	1,2	**n/A**		20	7	0	5	n/A	1	n/A	0	n/A	0	n/A	0	n/A
1988	**262**		2	243	91,7	27	10,2	9	3,4	3	1,1	0	0,0	**20**		22	7	0	27	87,1	2	6,5	0	0,0	0	0,0	0	0,0
1989	**268**		2	251	90,5	65	23,4	12	4,3	1	0,4	0	0,0	**42**		14	8	0	35	71,4	7	14,3	0	0,0	0	0,0	0	0,0
1990	**287**		7	270	92,3	72	24,6	16	5,5	2	0,7	0	0,0	**56**		17	14	2	48	75,6	19	29,9	2	3,1	1	1,6	1	1,6
1991	**298**		6	280	91,2	46	15,0	6	2,0	2	0,7	0	0,0	**71**		9	7	7	56	77,8	11	15,3	3	4,2	0	0,0	0	0,0
1992	**316**		1	280	88,3	36	11,4	12	3,8	1	0,3	0	0,0	**73**		6	6	1	57	75,5	9	11,9	3	4,0	0	0,0	0	0,0
1993	**318**		5	263	81,7	47	14,6	11	3,4	1	0,3	8	2,5	**78**		4	2	5	59	76,1	1	1,3	3	3,9	0	0,0	2	2,6
1994	**326**		2	276	84,1	68	20,7	9	2,7	4	1,2	0	0,0	**77**		9	7	3	53	66,3	16	20,0	0	0,0	1	1,3	0	0,0
1995	**330**		10	281	83,4	35	10,4	14	4,2	38	11,3	5	1,5	**83**		5	5	2	52	61,5	8	9,5	0	0,0	8	9,5	0	0,0
1996	**344**		6	280	80,5	28	8,0	9	2,6	36	10,3	0	0,0	**86**		6	4	13	56	67,9	6	7,3	2	2,4	10	12,1	0	0,0
1997	**352**	2	8	278	79,2	34	9,7	13	3,7	18	5,1	2	0,6	**79**		5	3	5	43	54,4	6	7,6	0	0,0	3	3,8	0	0,0
1998	**350**		14	299	81,9	31	8,5	14	3,8	32	8,8	0	0,0	**79**		14	9	11	45	55,9	8	9,9	0	0,0	7	8,7	0	0,0
1999	**380**	1	27	331	84,2	22	5,6	10	2,5	75	19,1	0	0,0	**82**		13	8	7	45	52,9	2	2,4	5	5,9	17	20,0	2	2,4
2000	**406**		13	332	81,4	25	6,1	6	1,5	31	7,6	1	0,2	**88**		11	5	7	51	56,7	3	3,3	5	5,6	6	6,7	0	0,0
2001	**410**	3	5	334	83,0	15	3,7	11	2,7	17	4,2	1	0,2	**92**	1	10	5	4	47	49,5	6	6,3	1	1,1	4	4,2	1	1,1
2002	**395**	7	1	274	72,4	5	1,3	4	1,1	4	1,1	1	0,3	**98**	4	6	3	5	38	38,6	1	1,0	1	1,0	1	1,0	1	1,0
2003	**362**	20	1	221	63,3	15	4,3	4	1,1	2	0,6	4	1,1	**99**	23	4	0	6	31	31,6	7	7,1	1	1,0	0	0,0	3	3,1
2004	**336**	21	3	188	57,3	16	4,9	6	1,8	0	0,0	1	0,3	**97**	17	5	2	5	32	33,0	2	2,1	0	0,0	0	0,0	4	4,1
2005	**320**	19	14	187	59,1	18	5,7	4	1,3	5	1,6	2	0,6	**97**	19	3	1	6	37	38,7	1	1,0	3	3,1	1	1,0	3	3,1
2006	**313**	18	20	193	60,6	13	4,1	8	2,5	8	2,5	2	0,6	**94**	14	16	9	3	37	36,8	4	4,0	5	5,0	0	0,0	1	1,0
2007	**324**	23	11	202	62,3	13	4,0	4	1,2	10	3,1	2	0,6	**107**	14	11	8	4	37	33,5	5	4,5	1	0,9	2	1,8	3	2,7
Σ / ∅	331	13	163	5457	78,3	650	9,7	191	2,8	291	3,8	32	0,5	80	13	210	120	96	891	57,0	125	8,3	35	2,1	61	3,6	21	1,1

Die Tabelle zeigt die Anzahl der jeweils zum Jahresanfang notierten Aktien (einschließlich Penny Stocks, jedoch ohne Zugänge aus dem Neuen Markt) und für die jeweiligen Jahre die Zahl der Penny Stocks, der Dividenden zahlenden Aktien (Bardividende bzw. Bonus > 0,00 €), der Kapitalerhöhungen aus Gesellschaftsmitteln, der Nennwertumstellungen, der Kapitalherabsetzungen, der Bezugsrechte (theoretischer Bezugsrechtwert > 0,00 €). Für den Geregelten Markt werden zusätzlich die Zu- und Abgänge dargestellt. Die Angaben „in Prozent“ beziehen sich jeweils auf die durchschnittliche Anzahl Aktien, die im Jahresverlauf im jeweiligen Segment notiert waren und berechnet sich aus der Hälfte der Summe der Anzahl der Aktien zu Beginn und zum Ende des Jahres.

Tabelle 2: Überblick zu den Size-Portefeuilles für den Geregelten Markt in Frankfurt, Juni 1988 bis Oktober 2007.

	Anzahl der Unternehmen					Portefeuillesgrenzen (Marktkapitalisierung in Mio. Euro, real)				Anzahl IPOs				Marktkapitalisierung der IPOs (in Mio. Euro, real)			
Jahr	D01 Micro	D02	D03 Small	Top 5%	Penny Stocks	D01 Micro	D02	D03 Small	Top 5%	D01 Micro	D02	D03 Small	Top 5%	D01 Micro	D02	D03 Small	Top 5%
1988	11	10	10	1		3-34	38-57	59-170	212-212	4	1	1	1	19-42	58	61	218
1989	14	12	12	2		3-49	50-70	71-210	221-461		2	5	1		64-68	85-178	254
1990	19	19	19	2		4-56	56-119	121-445	489-685	2	2	4	3	30-48	77-87	103-272	522-1041
1991	21	19	19	3		3-61	61-135	137-598	676-1016		3	3	1		62-98	161-240	864
1992	23	21	21	3		3-43	46-95	116-422	530-1066	2	2	2		34-47	71-86	149-162	
1993	22	22	22	3		3-33	34-88	92-312	317-1407		1	1			90	118	
1994	23	21	21	3		3-43	43-85	86-340	392-460	1	2	4		20	66-71	107-161	
1995	24	23	23	3		5-30	32-72	76-257	301-395		3	2			53-76	142-290	
1996	24	23	23	3		5-29	29-76	79-223	282-546		1	3			77	106-267	
1997	23	21	21	3		5-29	29-94	95-337	348-577		2	1			84-90	134	
1998	24	24	24	3		3-31	35-107	110-453	453-779	3	2	5		22-25	56-104	116-433	
1999	26	26	26	4		4-31	31-75	80-231	248-557	2	4	2		9-30	41-91	93-123	
2000	29	29	29	4		4-27	28-70	72-397	408-500	2	2		2	10-23	44-72		291-434
2001	30	28	28	4	1	2-17	19-51	53-267	296-567	1	3			9	35-42		
2002	27	27	27	4	4	2-11	12-36	37-268	306-490	2		1		11-16		45	
2003	25	25	25	3	22	1-7	9-29	30-426	472-1660								
2004	24	24	24	3	17	1-11	11-44	47-626	635-2808		2	1			28-31	58	
2005	26	26	26	4	19	0-10	10-44	45-625	946-2083			2				47-91	
2006	27	26	26	4	14	0-17	20-58	59-673	1466-2797	1	3	8		19	21-33	59-322	
2007	32	30	30	4	14	1-23	25-105	110-879	1122-3810		3	5			32-56	65-885	
∅	23,9	23,1	23,1	3,2	4,8	3-30	31-76	79-408	506-1144	20	38	50	8	28-18	72-56	226-97	562-430
Anteil	30,6%	29,6%	29,6%	4,1%	6,1%					17,2%	32,8%	43,1%	6,9%				

Die Size-Portefeuilles werden jeweils Ende Juni eines Jahres auf Basis der im Geregelten Markt notierten Unternehmen erstellt. Die einzelnen Aktiengattungen eines Unternehmen werden dabei zusammengefasst. Die Tabelle zeigt die Zuordnung der Unternehmen des Geregelten Marktes zu den Size-Portefeuilles D01 (Small) bis D03 (Large). Die marktwertmäßig größten Unternehmen (5 % aller Unternehmen) werden dem Portefeuille „Top 5%“ zugeordnet. Die Portefeuilles D01 bis D03 enthalten jeweils ca. ein Drittel der verbleibenden Aktien. Bei der Bildung der Size-Portefeuilles werden Penny-Stocks nicht berücksichtigt. Für die einzelnen Größenklassen werden die Marktkapitalisierungen (real, in Preisen von 2007) der jeweils kleinsten und größten Unternehmen angegeben. Die Anzahl der IPOs (Unternehmen) bezieht sich jeweils auf das angegebene Kalenderjahr, nicht berücksichtigt werden in der Tabelle die 6 IPOs in 1987. Die Zuordnung der IPOs zu den Größenklassen erfolgt anhand der Marktkapitalisierung zum Ende des Monats, in dem das IPO stattfand, bezogen auf die dargestellten Grenzen der Size-Portefeuilles zum Ende des jeweils unmittelbar vorangegangen Monat Juni. Für die IPOs werden ebenfalls die Marktkapitalisierungen (real, in Preisen von 2007) der jeweils kleinsten und größten Unternehmen angegeben.

Tabelle 4: Gründe für das Delisting aus dem Amtlichen Markt und dem Geregelten Markt in Frankfurt, 1987-2007.

Kategorie	Amtlicher Markt	in %	Geregelter Markt	in %
Börsen-/Segmentwechsel	33	5,7	50	23,8
Aufsteiger	n/A	n/A	41	19,5
Absteiger	10	1,7	3	1,4
Börsenwechsler	23	4,0	0	0,0
Going Privates	119	20,6	24	11,4
Squeeze Outs	96	16,6	16	7,6
Übernahmen durch Mehrheitsaktionär	16	2,8	5	2,4
Rechtsformwechsel	7	1,2	3	1,4
Insolvenzen und Liquidationen	8	1,4	10	4,8
Fusionen	68	11,8	3	1,4
Aktienumwandlungen	31	5,4	9	4,3
Summe	259	44,8	96	45,7

Die Tabelle stellt die Gründe und die Häufigkeiten für die Delistings von Aktien aus dem Amtlichen und Geregelten Markt dar. Die beiden Kategorien Börsen-/Segmentwechsel und Going Privates werden in Subkategorien unterteilt (dargestellt durch Einrückungen). Die Kategorisierung der Delistings erfolgt in Anlehnung an *Zillmer* (2003, S. 54). Die Prozentangabe (in %) bezieht sich auf die Gesamtzahl der Aktien im jeweiligen Marktsegment zwischen Mai 1987 und Oktober 2007. Die drei Unternehmen AIS AG, Bertrandt AG und Mühl Product & Service AG, welche in den Neuen Markt wechselten, werden keiner Subkategorie zugeordnet.

Tabelle 3: Risikoadjustierte Renditen des Geregelten Marktes in Frankfurt, 7/1988 - 10/2007.

	Monatliche Renditen			Vierteljährliche Renditen			Jährliche Renditen		
	Alpha	Beta	adj. R2	Alpha	Beta	adj. R2	Alpha	Beta	adj. R2
				Gleichgewichtete Renditen					
BJS	3,39	0,50	0,41	3,06	0,59	0,43	2,61	0,81	0,44
	(0,92)			(0,78)			(0,40)		
BJS (adj.)	1,98	0,67	0,46	0,84	0,83	0,50			
	(0,58)			(0,22)					
				Marktwertgewichtete Renditen					
BJS	0,25	0,54	0,45	-0,41	0,61	0,53	-1,95	0,87	0,63
	(0,08)			(-0,13)			(-0,67)		
BJS (adj.)	-0,75	0,66	0,48	-2,57	0,85	0,60			
	(-0,26)			(-0,72)					

Zur Schätzung der Regressionsparameter verwenden wir das Standardmodell nach *Black/Jensens/Scholes* (1972, BJS) gemäß Gleichung F1. Weiterhin verwenden wir ein erweitertes Regressionsmodell, BJS (adj.), welches zusätzlich die Marktüberschussrendite der Vorperiode (1 Lag) einbezieht (vgl. Gleichung F2). Die abhängigen Variablen werden durch die Überrenditen des Portefeuilles der im Geregelten Marktes in Frankfurt notierten Aktien bestimmt (Juli 1988 bis Oktober 2007, inkl. Körperschaftsteuergutschrift). Das Portefeuille wird jeden Monat neu bestimmt. Bei der Bildung der Portefeuilles werden ausschließlich deutsche Aktien, die zeitgleich an keiner anderen Börse amtlich notierten berücksichtigt. Aktien, die aus dem Neuen Markt in den Geregelten Markt wechselten, werden nicht berücksichtigt. Die unabhängigen Variablen werden durch die Überrenditen des marktwertgewichteten Portefeuilles aller im Amtlichen Markt in Frankfurt notierten deutschen Aktien bestimmt (inkl. Körperschaftsteuergutschrift). Als risikofreien Zinssatz verwenden wir dem Renditeintervall entsprechende Geldmarktsätze am Frankfurter Bankplatz (Zeitreihen: SU0104, SU0107, SU0235). Die Alphas (in %) werden zur besseren Vergleichbarkeit der Ergebnisse annualisiert. Die für die Alphas angegebenen t-Werte sind nach *Newey/West* (1994) adjustiert. Die Zeitreihenregression nach BJS wird auf Basis von monatlichen, vierteljährlichen und jährlichen Renditeintervallen durchgeführt. Zusätzlich betrachten wir gleich- sowie marktwertgewichtete Renditen der Aktien des Geregelten Marktes in Frankfurt.

Tabelle 5: Risikoadjustierte Renditen für nach Size sortierte Portefeuilles, 7/1988-10/2007.

	Gleichgewichtet					Marktwertgewichtet				
	D01 (Micro)	D02	D03 (Small)	Top 5%	D01-D03	D01 (Micro)	D02	D03 (Small)	Top 5%	D01-D03
Alpha	4,09	-7,02	0,51	-10,35	-0,86	1,06	-5,72	2,60	-8,41	1,52
t-Wert	(0,65)	(-3,35)	(0,06)	(-2,06)	(-0,21)	(0,24)	(-2,99)	(0,31)	(-1,66)	(0,22)
Beta	0,84	0,83	0,81	0,95	0,82	1,61	0,81	0,74	0,78	0,82
adj. R2	0,28	0,62	0,51	0,39	0,55	0,36	0,63	0,36	0,37	0,52

Die Tabelle zeigt die Ergebnisse der Marktmodell-Regression nach *Black/Jensens/Scholes* (1972, BJS) auf Basis von gleich- und marktwertgewichteten jährlichen Überrenditen für den Zeitraum Juli 1988 bis Juni 2007 (19 Beobachtungen). Die abhängigen Variablen werden durch die jährlichen Überrenditen der Size-Portefeuilles D01 bis D03 und Top 5% bestimmt. Die Size-Portefeuilles werden jeweils Ende Juni im Jahr t erstellt. Bei der Bildung der Size-Portefeuilles werden ausschließlich deutsche Aktien, die zeitgleich an keiner anderen Börse amtlich notierten berücksichtigt. Aktien, die aus dem Neuen Markt in den Geregelten Markt wechselten, werden nicht berücksichtigt. Die Renditen für die Size-Portefeuilles werden für die Monate Juli im Jahr t bis Juni im Jahr t+1 berechnet (inkl. Körperschaftsteuergutschrift). Die unabhängigen Variablen werden durch die jährlichen Überrenditen des marktwertgewichteten Portefeuilles aller im Amtlichen Markt in Frankfurt notierten deutschen Aktien bestimmt (inkl. Körperschaftsteuergutschrift). Der risikofreie Zinssatz wird durch die Bundesbankzeitreihen SU0235 bestimmt. In der Spalte D01-D03 werden die Aktien der Size-Portefeuilles D01 bis D03 zusammengefasst. Die für die Alphas angegebenen t-Werte sind nach *Newey/West* (1994) adjustiert.

Tabelle 6: Risikoadjustierte Renditen der Aktien der Size-Portefeuilles D01 bis D03, fünfjähriger Subperioden, vierteljährliche Renditeintervalle, 7/1988-10/2007.

Panel A: Portefeuille der Aktien der Size-Portefeuilles D01-D03

	Gleichgewichtet				Marktwertgewichtet			
	Alpha	(t-Wert)	Beta	adj. R2	Alpha	(t-Wert)	Beta	adj. R2
1. Subperiode: 7/1988-6/1993								
BJS	-1,44	(-0,28)	0,76	0,64	-1,15	(-0,19)	0,81	0,73
BJS (adj.)	-1,97	(-0,39)	0,87	0,64	-1,71	(-0,53)	0,93	0,74
2. Subperiode: 7/1993-6/1998								
BJS	-10,02	(-1,19)	0,95	0,61	-10,45	(-1,76)	0,97	0,63
BJS (adj.)	-14,48	(-1,63)	1,21	0,66	-16,25	(-4,20)	1,31	0,74
3. Subperiode: 7/1998-6/2003								
BJS	-7,31	(-1,40)	0,45	0,49	-3,26	(-0,63)	0,45	0,42
BJS (adj.)	-5,95	(-1,30)	0,60	0,50	-1,51	(-0,33)	0,64	0,44
4. Subperiode: 7/2003-10/2007								
BJS	15,00	(1,22)	0,44	0,05	20,41	(1,53)	0,44	0,09
BJS (adj.)	4,11	(0,29)	0,89	0,05	19,71	(0,97)	0,47	0,02

Panel B: Portefeuille der Aktien der Size-Portefeuilles D01-D03, exklusive IPOs

	Gleichgewichtet				Marktwertgewichtet			
	Alpha	(t-Wert)	Beta	adj. R2	Alpha	(t-Wert)	Beta	adj. R2
1. Subperiode: 7/1988-6/1993								
BJS	-1,00	(-0,22)	0,66	0,62	-1,86	(-0,33)	0,78	0,70
BJS (adj.)	-1,62	(-0,38)	0,80	0,63	-2,34	(-0,51)	0,89	0,70
2. Subperiode: 7/1993-6/1998								
BJS	-8,10	(-0,89)	0,81	0,48	-7,93	(-1,02)	0,83	0,51
BJS (adj.)	-11,57	(-1,20)	1,01	0,50	-12,11	(-1,35)	1,07	0,56
3. Subperiode: 7/1998-6/2003								
BJS	-0,46	(-0,08)	0,32	0,34	1,29	(0,18)	0,36	0,41
BJS (adj.)	-0,85	(-0,23)	0,28	0,30	0,89	(0,14)	0,31	0,38
4. Subperiode: 7/2003-10/2007								
BJS	13,96	(1,30)	0,39	0,04	22,03	(1,95)	0,37	0,06
BJS (adj.)	1,66	(0,12)	0,91	0,09	23,35	(1,39)	0,31	-0,01

Darstellung der Ergebnisse zur Marktmodell-Regression auf Basis von Überrenditen für vierteljährliche Beobachtungsintervalle. Die Alphas (in %) wurden zur besseren Vergleichbarkeit der Ergebnisse annualisiert. Die abhängigen Variablen werden durch die vierteljährlichen Überrenditen des Portefeuilles der Aktien der Size-Portefeuilles D01 bis D03 für den Zeitraum Juli 1988 bis Oktober 2007 bestimmt. Vgl. Tabelle 5 zu Erstellung der Size-Portefeuilles. Die unabhängigen Variablen werden durch die vierteljährliche Überrenditen des marktwertgewichteten Portefeuilles aller im Amtlichen Markt in Frankfurt notierten deutschen Aktien bestimmt (inkl. Körperschaftsteuergutschrift). Der risikofreie Zinssatz wird durch die Bundesbankzeitreihen SU0107 bestimmt. Die für die Alphas angegebenen t-Werte sind nach *Newey/West* (1994) adjustiert. In Panel B werden ausschließlich Aktien berücksichtigt, deren IPO mind. fünf Jahre zurückliegt. Zur Schätzung der Dimson-Betas wird ein Lag verwendet.

Tabelle 7: Risikoadjustierte Renditen des Geregelten Marktes in Frankfurt, exklusive IPOs, 7/1988-10/2007.

	Monatliche Renditen			Vierteljährliche Renditen			Jährliche Renditen		
	Alpha	Beta	adj. R2	Alpha	Beta	adj. R2	Alpha	Beta	adj. R2
	Gleichgewichtete Renditen (ohne IPOs)								
OLS	6,07	0,41	0,31	5,72	0,49	0,36	6,15	0,59	0,28
	(1,77)			(1,47)			(1,02)		
BJS (adj.)	4,59	0,59	0,37	4,31	0,65	0,38			
	(1,40)			(1,14)					
	Marktwertgewichtete Renditen (ohne IPOs)								
OLS	4,01	0,46	0,34	3,33	0,52	0,45	2,71	0,65	0,42
	(1,40)			(1,00)			(0,48)		
BJS (adj.)	2,93	0,59	0,37	2,07	0,66	0,47			
	(1,03)			(0,63)					

Siehe Tabelle 4 für Details. Im Unterschied zu Tabelle 4 werden IPOs für die ersten 60 Monate nach Aufnahme der Börsennotiz (unabhängig vom Marktsegment oder Börse) bei der Bildung des Portefeuilles der im Geregelten Markt in Frankfurt notierten Aktien ausgeschlossen.

Tabelle 8: Annualisierte Durchschnittsrenditen der Aktien des Geregelten Marktes in Frankfurt, 7/1988-10/2007.

		Size-Portefeuilles					Geregelter Markt				AMX
Periode	Mean	D01 (Micro)	D02	D03 (Small)	Top 5%	D01-D03	GG	MWG	GG*	MWG*	
7/1988-10/2007	arith.	12,8	3,8	10,6	0,8	9,1	12,1	9,2	14,1	12,2	12,9
7/1988-10/2007	geom.	11,2	2,5	9,5	-2,7	8,2	11,2	8,1	13,2	11,2	11,2
7/1988-6/1993	arith.	10,1	5,8	10,0	0,8	8,7	7,6	8,1	8,3	7,8	11,5
7/1993-6/1998	arith.	18,0	8,6	10,9	5,4	12,7	14,4	11,3	14,7	14,1	24,0
7/1998-6/2003	arith.	-2,2	-12,8	-8,2	-26,5	-7,6	-4,1	-8,7	3,2	0,0	-5,4
7/2003-10/2007	arith.	27,1	15,0	32,8	26,9	24,8	33,4	28,6	32,6	29,1	22,8

Die dargestellten Durchschnittsrenditen basieren auf monatlichen Portfeuillerenditen (inkl. Körperschaftsteuergutschrift). Für die Size-Portefeuilles D01 (Micro) bis D03 (Small) und Top-5% werden gleichgewichtete Durchschnittsrenditen angegeben. Die Spalte D01-D03 umfasst alle Aktien, exklusive der 5 % der größten Aktien (Top-5%). Vgl. Tabelle 5 zu Erstellung der Size-Portefeuilles. Für den Gesamtmarkt werden marktwert- (MWG) und gleichgewichtete (GG) Durchschnittsrenditen angegeben. GG* bzw. MWG* bedeutet, dass IPOs innerhalb der ersten fünf Jahren nach der ersten Börsennotiz nicht berücksichtigt werden. Dir Durchschnittsrenditen für den Amtlichen Markt werden durch die AMX-Zeitreihe bestimmt. Dieser basiert auf dem marktwertgewichteten Portefeuille aller im Amtlichen Markt in Frankfurt notierten deutschen Aktien.

PART III

In Germany the CAPM is Alive and Well

Contents

In Germany the CAPM is Alive and Well†

Zusammen mit Patrick Lehmann und Richard Stehle*

Abstract

Using data on all firms listed in the top segment of the Frankfurt Stock Exchange during the years 1960 to 2007, we investigate how the (Sharpe-Lintner) CAPM performs under the assumption that the German capital market is totally segmented from other capital markets. We also check whether this model should be extended by the firm characteristics size and book-to-market. We can identify strong size and book-to-market effects in the German stock market. However, their direction, strength, and interaction are different in the two subperiods 1960-1990 and 1990-2007.

We use the standard test procedures (BJS, GRS, Fama/MacBeth) to test the CAPM and do a large number of tests which differ by the length of the test period, the length of the return interval, beta calculations, firm level and portfolio data, sorting, and weighting. The total number of CAPM rejections is somewhat higher than what we would expect based on the statistical significance level. Long-term GRS tests often lead to rejections of the CAPM, especially in the second subperiod and in sorts on anomalies. Short term GRS-tests always reject the CAPM during the years 2000 to 2005. The results of Fama/MacBeth cross-sectional regressions depend on sorting, weighting and beta calculation. When we sort on beta and use value-weight portfolios the results for the full period, 1960 to 2007, are fully in line with the CAPM.

Our interpretation of the results is that in Germany the pure domestic version of the CAPM works better than an extended model. It also works better for large firms than for small firms.

† Similar titles have been used by Jagannathan/Wang (1996) for an earlier working paper and by Levy (2010).

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1 Introduction

The capital asset pricing model (CAPM) of Sharpe (1964) and Lintner (1965) has been discussed, tested and applied during the last 50 years, first in the U.S, then around the world.[1] To our knowledge, it has been used extensively for calculating the equity cost of capital in Germany during the past 10 years. A prominent supporter of the CAPM has been the German monopoly watchdog, the Monopolkommission. Especially well-documented is the model's use in legal proceedings on the freeze-out of minority shareholders,[2] in network regulation,[3] and in the evaluation of mutual fund performance.[4] In these applications, it is typically assumed that the German stock market is totally segmented from other markets. That is, the German risk free rate, an estimate for the German risk premium, and "German" betas are used. A recent application assumed an integrated European capital market. Following the "worldwide" discussion of CAPM anomalies, it is discussed in Germany whether the CAPM should be extended by the two most prominent anomaly variables, size and book-to-market (ratio) or by factors that represent these characteristics. In the area of mutual fund evaluation, momentum is considered as an additional explanatory variable.[5] It is also being discussed, whether the Sharpe-Lintner model should be interpreted nationally or internationally[6] and/or whether it should be replaced by another asset pricing model, e.g. the after-tax CAPM,[7] a more complicated international CAPM,[8] the zero-beta CAPM, or a combination of these models.

We use data for the top segment of the Frankfurt Stock Exchange for the period from 1960 to 2007 to investigate how the CAPM performs under the assumption that the German capital market is totally segmented from other capital markets. We also check whether this model should be extended by the firm characteristics size and book-to-market. We focus on the two most important anomaly variables

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1 We follow the literature and use the acronym CAPM only to refer to the model originally proposed by Sharpe (1964) and Lintner (1965), see Fama/French (2004), FN 1. We use the CAPM and the Sharpe-Lintner model as synonyms.

2 Freeze-outs of minority shareholders are regulated by the "Wertpapiererwerbs- und Übernahmegesetz" in 2002. The OLG (Regional Appeal Court) Düsseldorf decided, e.g., on May 27th, 2009 (I-26W 5/07) that the CAPM is the most important model for the estimation of the cost of capital for valuation purposes. The OLG Stuttgart discussed the appropriate risk premium extensively in its decision dated May 4th, 2011 (20 W 11/08). Typically, the court decisions are based on company valuation appraisals prepared by public accountants, who typically are members of the Institut der Wirtschaftsprüfer in Deutschland e.V. (IDW). The IDW has recommended the CAPM since June 28th, 2000.

3 Presently, the CAPM is used to regulate: telecommunication, gas, and electric power networks. The mobile phone termination fee, e.g., has been based on the CAPM since December 1st, 2010, the fixed line termination fee since April 1st, 2011. Sudarsanam (2011) reviews the models use in many other countries.

4 Jensen's alpha is frequently used to evaluate the performance of mutual fund managers. It is calculated as the difference between the average portfolio return and its risk adjusted model return of the CAPM. In the academic literature Jensen's alpha is still used in performance evaluation studies—at least in addition to more comprehensive models like the Fama/French three-factor model or the Carhart four-factor model (see for example the recent articles by Evans (2010) and Fama/French (2010)). It is also displayed in publicly available fund information systems (e.g. Morningstar).

5 Recent articles about the momentum effect include Bulkley/Nawosah (2009) and Fama/French (2008).

6 See Stehle (1977). We concentrate on the pure national interpretation. Fama/French (2011) argue that local models work better than global models, especially if the models include factors.

7 Since 2002, the IDW recommends usage of either the CAPM or the (After) Tax CAPM of Brennan (1970). Schulz/Stehle (2005) conclude that in Germany the Tax CAPM performs better than the CAPM. However, the relevant tax laws changed in 2008. Therefore, the after-tax CAPM has lost importance in Germany.

8 The discussion of international CAPMs is less intense than the discussion of national CAPMs. A recent contribution is Dolde et al. (2012).

because we believe that the estimation of the cost of equity capital is the most important application of the model.[9]

We use the time-series test proposed by Jensen (1968) and Black/Jensen/Scholes (1972) [BJS], and the cross-sectional test proposed by Fama/MacBeth (1973) [FM]. These were refined in a large number of studies, notably by Fama/French (1992) and Gibbons/Ross/Shanken (1989) [GRS]. Since the three procedures are based on different assumptions and test objectives, and look at the time-series of cross-sectional data in different ways, we consider them as ideal complements to each other, especially when the same set of test portfolios are used, which is what we do.

There already exist several studies that apply variations of these procedures to German data, most recently Schrimpf et al. (2007), Amel-Zadeh (2011), and Artmann et al. (2012a, 2012b). These studies typically find that extended models describe the cross-section of returns "better" than the Sharpe-Lintner model. Artmann et al. (2012a, p. 8) even conclude that the CAPM is useless in explaining the cross-section of returns: "Beta remains dead." However, Artmann et al. (2012b, p. 20) also point to the major weakness of the alternative models: "none of the models can consistently explain the cross-section of [German] returns."

Our objective is to build on and to improve these studies.

Most recent studies of the German market are based on monthly data, rates of return on either equal-weight or (market) value-weight portfolios, and OLS betas. Some studies only look at a short time period, while others look at a longer time period, but not at subperiods. Some studies include the tax refund in the amount of the corporate income tax, which German investors received between 1977 and 2000, in the rate of return calculation, while others do not. Several studies include stocks from different segments, which make an interpretation of the results difficult. Some studies contain a survivorship bias. Some studies look at individual stocks, some at firms, that is, they look at the total equity portfolio in case of dual class share structures. The firm characteristics size and book-to-market ratio are calculated in different ways. In some studies the grouping procedures used are not optimal. Finally, different proxies for the market portfolio are applied. We will discuss the most serious shortcomings of prior papers throughout our paper.

Our study differs from existing studies on the German market in several important ways. The most important difference is we look at the input data and the related methodological questions more intensively. This issue has been neglected by most prior studies. On some aspects of the proper input data for a German CAPM test we have very strong beliefs, and as a consequence, use the same data throughout the paper. Most of these aspects are discussed in Section 2. They are:

[9] Size and/or book-to-market anomalies have been reported for Germany among others by Oertmann (1994), Sattler (1994), Schlag/Wohlschieß (1997), Stehle (1997), Bunke et al. (1999), Wallmeier (2000), Schulz/Stehle (2002), Amel-Zadeh (2011) and Artmann et al. (2012a).

- We focus on the top segment of the Frankfurt stock exchange. Firms are included for exactly the period they have actually been listed in this segment.
- We look at firm data, i.e., we combine all classes of equity in dual share structures. We also consider unlisted shares or shares listed in other market segments and stock exchanges.
- We include the tax refund in the amount of the corporate income tax in the rate of return calculation on individual stocks.
- Before December 1990 we use book values of equity from consolidated statements only if non-consolidated statements are not available to us. After 1990, we primarily use consolidated statements from Worldscope.
- We use the rates of return on the "market portfolio" calculated by ourselves. This guarantees that this portfolio has the same characteristics throughout the time period we look at.
- We use firm characteristics as independent variables, not factor returns.[10]
- When we look at portfolios, all portfolios contain roughly the same number of firms.

With respect to other aspects of the proper input data for a German CAPM test, we have either very weak beliefs and/or we want to demonstrate the effects of the input data choice on the test results. As a consequence, we use several input data alternatives. Most of these data aspects are discussed in Section 4. They are:

- Beta calculation in a FM framework: OLS vs. Dimson betas and full-period vs. rolling betas.
- Equal-weight and value-weight portfolio returns.
- Since discrete time CAPMs do not specify the length of the modeled time period, we alternatively base our tests on monthly, quarterly, and annual rates of return. The latter return types may correspond better to the decision processes of investors. In addition, they are less affected by seasonal effects and by illiquidity, which is a major problem for many small stocks in Germany.
- We use a variety of sorting procedures in the creation of portfolios: single sorts on size, beta and book-to-market, and double sorts on all combinations of these characteristics.
- We use portfolio data and alternatively firm data in the way Fama/French (1992) did. In the former case we use 10, 16, or 20 portfolios in single sorts, 2x2, 3x3, 4x4, 5x5, and 6x6 portfolios in double sorts.

Important other differences with previous studies are:

- We have a longer total observation period than all prior studies, 1960 to 2007. In addition to analyzing the data for the full period, we look at and compare two subperiods, 1960-1990 and 1990-2007.

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[10] Daniel/Titman (1997) test empirically whether factor models have additional explanatory power compared to characteristic models. They conclude that it is the characteristics that explain the cross-section of stock returns. See also Daniel et al. (2001) and Daniel/Titman (2012).

Our empirical analysis of the full time period and the two subperiods, 1960-1990 and 1990-2007, is complicated by the fact that in Germany full period betas and size are strongly and positively correlated in both subperiods. For sorts on anomaly variables, rolling portfolio betas vary considerably over time. Important points of our paper are:

- Grouping, weighting, beta calculation, and the return interval all influence the results considerably and their interpretation should be taken into account carefully.
- Weighting makes a big difference whenever we sort on criteria other than size.
- Using full period betas based on annual data instead of full period Dimson betas based on monthly data improves the performance of the CAPM.

Both the size and the book-to-market effect play an important role in the German capital market. However, both effects and their interaction are not stable over time and across portfolios.[11] Based on the results of a large number of tests, our major conclusions are:

- Given the strong theoretical foundation of the Sharpe-Lintner CAPM, the favorable empirical results for it, and the inconclusive results for models that involve two or three independent variables, we therefore, strongly recommend its use for calculating the cost of capital.
- Investors who are less impressed by the theoretical elegance of the Sharpe-Lintner CAPM possibly will interpret our results that they should overweigh large firms with a high book-to-market ratio, underweight firms that are either small or have a low book-to-market ratio, and avoid firms that have both characteristics.

In Section 2, we discuss the most important institutional aspects in which the German stock market differs from the U.S. and the UK markets, especially those, which must be taken into account when testing CAPMs. They are:

- Germany had eight stock exchanges at the beginning of the time period we look at. Frankfurt and Düsseldorf competed for the top position, while Berlin, the leading exchange before WWII, still played a major role. Hamburg and Munich also played important roles. In addition, there were three "provincial stock exchanges", Bremen, Stuttgart, and Hannover. At the end of the time period we look at, Frankfurt was by far the most important stock exchange. However, the other exchanges still exist today.
- All German exchanges had three segments from 1960 to 2007, and from 1997 to 2003 Frankfurt added a fourth segment, the Neuer Markt. Most IPOs occurred in lower segments. Over time, many stocks moved from a lower to a higher and/or from a regional to a more important exchange.
- Dual stock classes (common and preferred stocks) are much more important than in the U.S.

[11] The (in)stability of the size and the book-to-market effect is discussed in several studies, recently, e.g., in Levy (2010) on pages 64 and 65. Brown et al. (1982) are the first to show that the size effect is not stable through time.

- The refund of the corporate income tax paid on dividends at the personal level (Körperschaftsteuergutschrift) between 1977 and 2000.
- The weaknesses of the existing indices, which are typically used as proxies for the "market portfolio".

In Section 3, we discuss some important characteristics of the firms in our sample on the basis of summary statistics for size sorted decile portfolios. We also present the average returns and related statistics of these portfolios.

Before we present our empirical results, we discuss the most important variations in the test methodology in Section 4. For example, we consider questions such as: should we group firms into portfolios or not? If we do our test on portfolios, should we look at equal-weighted or value-weighted portfolios? What is the appropriate return interval? We also address problems inherent in some variations of the basic test procedures. We conclude that sorts on size are not optimal because results are driven by many small firms. We also show that betas are not stationary over time for most size sorted portfolios. Based on our discussion in Section 4 we report the results of a large number of informal analyses, cross-sectional, and time series regressions in Section 5.

2 German peculiarities, German data, our initial sample

2.1 German stock exchange segments

Our return data covers the time period 1953 to 2007. Throughout most of this period, 8 major stock exchanges existed in Germany. In addition to this 'horizontal' segmentation there was a 'vertical' segmentation.[12] We only focus on the Amtlicher Markt[13] in Frankfurt, the top segment of the Frankfurt stock exchange, which over time, became by far the most important stock exchange in Germany in terms of trading volume. The Amtlicher Markt was regulated by a national law (Börsengesetz, stock exchange act) since 1896 and was considered the only "official" German market segment until May 1987. The lower market segments were traditionally subject to private law and not regulated by the stock exchange act. Hence, they are also referred to as "non-official" market segments. Until May 4th, 1987, the two lower segments were the Geregelter Freiverkehr and the Ungeregelter Freiverkehr. In

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12 In January 1958, 17 German stocks were listed in the top segment at all eight German exchanges. Typically the trading volume was highest at the Heimatbörse (home exchange). At this time, Frankfurt was already the exchange with the highest total trading volume, Düsseldorf, the center of the coal and steel industry, was in a close second place, and Berlin, Munich and Hamburg were also important exchanges. Seventy stocks were traded in the top segments of the five most important exchanges. Most other stocks were listed in the top segment of their home exchange and in the top or lower segments of several other exchanges. Altogether 662 stocks were listed in at least one top segment. In addition, 133 stocks existed in January 1958, which were only listed in the second segments.

13 If we refer to specific German institutions, securities, or types of transactions we will typically use the German terms; the English translations are often not used consistently. Some studies, for ex., translate 'Amtlicher Markt' (until July 1st, 2002 the official name was Amtlicher Handel) with 'official market'. This neglects the fact that the former second market segment, the "Geregelter Markt", which some translate with "regulated market" was also an official market in legal terms. From November 1st, 2007, all stocks previously listed in the Amtlicher Markt or Geregelter Markt were transferred to the 'Regulierter Markt', which is often translated as 'regulated market'. However, the Geregelter Markt and Amtlicher Markt were also regulated markets.

May 1987, the Geregelter Freiverkehr was replaced by the Geregelter Markt. This new segment was briefly mentioned in the stock exchange act of 1986, but it was mainly regulated by the stock exchanges themselves. The lowest segment, the Ungeregelter Freiverkehr, was replaced by the Freiverkehr (renamed to "Open Market" in 2005) on May 1st, 1988.

In the nineties, additional segments were introduced at some exchanges, most importantly the Neuer Markt at the Frankfurt stock exchange, which was opened in 1997. This segment may be compared to the NASDAQ in New York, the AIM in London, or the Nouveau Marché in Paris. This segment attracted a large number of IPOs of young technology firms and was therefore according to Vitolis (2001) initially considered a tremendous success. However, many irregularities and a disastrous performance from 2000 to 2002 (burst of the dot com bubble) severely damaged the reputation of this segment, which had tried to attract both, institutional and private investors. As a consequence it was closed in June 2003 (last trading took place in March 2003). Most firms of the Neuer Markt were transferred to the Geregelter Markt. Since November 2007, only two market segments remain in Frankfurt, the Open Market and the Regulierter Markt, the former Geregelter Markt and the Amtlicher Markt were closed and all firms listed in these segments were transferred to the Regulierter Markt.

In 2007, at the end of the time period considered by our study, 95% of the total trading volume on all German stock exchanges took place in Frankfurt.[14] By that time, the computer based trading system XETRA (introduced in Novemeber 1997) was by far the dominant system, only 10% of the trades took place on the traditional exchange floor (Präsenz- or Parketthandel), which was replaced by XETRA in May 2011. We use floor prices throughout our sample period.

2.2 Dual class firms

Many German firms issue two classes of stock, Stammaktien (typically translated with common stocks) and Vorzugsaktien (non-voting stocks which are typically translated with preferred stocks). In Germany, the risk-return characteristics of non-voting stocks are very similar to those of common stocks.[15] German non-voting stocks are very similar to the U.S. common stock class of dual-class firms, which has inferior voting power. Major differences between the German non-voting stock and U.S. common stocks with inferior voting power are

- that German non-voting stocks typically, by the company charter, have a small dividend advantage compared to common stocks, there is no upper limit for their dividend;
- typically they also have a minimum dividend, which is cumulative, that is, if it cannot be paid in one year, it must be paid in the following year(s)
- typically they have no votes (common stocks have 1 vote per share); in the U.S., the common stocks with inferior voting power typically have one vote, the common stock with the superior

[14] Factbook Deutsche Börse AG (2007), p. 14.
[15] Daske/Ehrhardt (2002) discuss and investigate Stamm- and Vorzugsaktien in Germany.

voting power typically has 10 votes.[16]

Major differences between dual class firms in the U.S. and Germany are:

- Dual class firms are more important in Germany. Gompers et al. (2010) estimate that about six percent of the publically traded companies in the United States issue more than one class of common stock. In our German sample, on non-financial firms roughly 11% of the stocks are preferred stocks, some of them having a very large market capitalization.
- In Germany, in most cases, both classes are exchange listed. Typically, both classes are listed on the same exchange and in the same segment. In the U.S., typically only the common stock class with the inferior voting power is listed. However, cases exist in which the common stock is only listed in the home market and/or in a lower segment.
- In German dual class firms, typically 50% of the shares outstanding are non-voting stocks. This is also the legal maximum; the other 50% are the stocks with the superior voting power. In the U.S., the number of shares with superior voting power is typically a much smaller fraction of the total number of shares.
- In the U.S., these shares are usually held by directors and managers, in Germany, typically only 50% of these stocks are held by the majority shareholder.

2.3 Initial Sample Selection

As a consequence of the existence of two share classes with equity like characteristics, which in most cases are both listed, the way in which the two share classes are included in the analysis is an important decision in empirical studies of the German stock market. Prior studies have used the following alternatives:[17]

- both classes of shares are included as separate observations. This alternative has been chosen by several studies which only use stock characteristics (and not firm characteristics) as explanatory variables, for example Stehle (1997);
- only one observation per firm is used as a dependent variable. This is the standard procedure in studies that include firm characteristics as independent variables and in studies that use factors as independent variables.

We use the second procedure, that is, the rate of return on the total equity portfolio of the firm as the dependent variable in our regression equations. Whenever possible, if both classes are exchange listed, we calculate this rate of return precisely. When one class of shares is not listed, we use the prices of the listed type to estimate the rate of return on the firm's total equity. We estimate the (total) market

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[16] For these and other details of U.S. dual class firms see Gompers et al. (2010). Dual-class firms and their characteristics are only discussed and analyzed in a small number of studies. Gompers et al. (2010, p. 1052) speculate that "perhaps because the identification of these firms is highly labor intensive and has only become feasible with the recent availability of electronic documents from the SEC."

[17] Not all studies state clearly what they are doing, e.g. Elsas et al. (2003).

value of a firm's equity by aggregating the market value over all share classes.[18] Most prior studies simplify this procedure by using the rate of return of only one class as an estimate of the rate of return on the firm's total equity.[19]

As a consequence of the existence of several stock exchanges, each having several segments, another decision that must be made is which firms are included in the analysis. We include all firms, which have at least one class of shares listed in the top segment of the Frankfurt stock exchange, the Amtlicher Markt. We do not include firms solely listed in lower segments or other stock exchanges. Our explicit concentration on the top segment of the Frankfurt stock exchange is a major difference to some recent studies. The most important reason for this decision is, currently we do not have a data set that fully covers all stocks listed on the other exchanges and in lower segments with a sufficient data quality. Existing data sets most likely do not include all stocks listed at a time and therefore may contain a selection or survivorship bias. For small firms the probability of not being included in the data set is higher than for large firms. For surviving firms the probability of being included is higher than for dead firms.[20] There is also reason to believe that data quality is lower for small firms not listed in Frankfurt. For our sample of stocks listed in Frankfurt's top segment we have carefully checked all ingredients of the data that goes into our rate of return calculations (see Appendix A1 for more details). In addition to price changes, regular dividends, pure stock splits (Nennwertumstellungen), rights issues (Bezugsrechtsemissionen) and stock dividends (Kapitalerhöhungen aus Gesellschaftsmitteln) contribute significantly to the rate of return of a stock in Germany. Since German small and large stocks differ with respect to these input factors for the rate of return calculation (see section 3.1), data quality problems may bias the results.

Despite of our focus on the stocks listed in the top segment of the Frankfurt stock exchange, our results give a good picture of what happened in the top segments of all eight German stock exchanges. All of these top segments are regulated in the same way. The stocks listed in the top segment of other exchanges, but not in the top segment of the Frankfurt exchange, are mainly small companies, which on average, may have performed in a similar way as comparable companies which are listed in Frankfurt. With respect to the general economic development of the different regions in Germany between 1960 and 2007, the Frankfurt area is neither at the bottom nor at the top.

The main reason for not including the stocks listed only in the lower segments or the Neuer Markt are IPO effects and additional market microstructure effects. In a large number of U.S. studies, e.g. Ritter

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[18] Studies that focus on firms use different procedures in this respect.

[19] Typically, the rate of return on the common stocks is used. The most recent study, Artmann et al. (2012b) uses the class for which the longer data history is available.

[20] Artmann et al. (2012b, p. 23) "[…] include all firms listed on the market segments 'Amtlicher Handel' or 'Neuer Markt'. In addition, [they] consider stocks of firms listed on 'Geregelter Markt' if they were listed on 'Amtlicher Handel' or 'Neuer Markt' at any time during [their] sample period." We believe that this setup introduces an ex post selection bias as well as a survivorship bias. Brückner/Stehle (2012) indicate firms that made it from the Geregelter Markt to the Amtlicher Markt were among the most successful firms ("winners").

(1991) and Loughran/Ritter (1995), it has been documented that stocks, in the first three to five years after their IPO, underperform the market. Several studies report a dramatic underperformance. In Germany, IPOs take place in all segments. However, a relative large number took place in the lower segments and in the Neuer Markt. Neuhaus/Schremper (2003) indicate a stronger long run underperformance of German IPOs in the lower segments compared to the top segment of the Frankfurt stock exchange.

A market microstructure effect in the U.S. has been documented by Reinganum (1990). Some argue that this is mostly an IPO effect.[21] Loughran (1993) showed that this effect is not only related to IPOs. In the U.S., even firms from different market segments that have been listed for several years are not priced in the same way.[22] Brückner/Stehle (2012) summarize the differences in legal supervision, admission, and listing requirements between the German market segments, which could provoke a market microstructure effect. Since most firms listed in lower market segments are extremely small compared to large firms from the top segment in terms of the market value of the equity, they would be primarily allocated to the lower size deciles. IPOs and additional market microstructure effects could therefore bias our regression results. In other words, it would be unclear whether regression results are driven by IPO and/or market microstructure effects, or solely by size and/or book-to-market effects.[23]

For not including stocks listed in the Neuer Markt additional reasons apply. This market segment existed only for a few years, from 1997 to 2003. As a consequence of a large number of IPOs, nearly as many stocks were listed in this segment in 2000 as in Frankfurt's top segment. These stocks had performed really well for a while, then crashed. The index level at the end was only 5% of the maximum level in 2000. As a consequence, the arithmetic and the geometric mean return for these stocks differ considerably and it is unclear, whether the standard procedures used in empirical analyses are appropriate.

Stocks registered in the lowest segments are excluded in most, but not all studies. Some studies make no statements in this respect. Several recent studies on the German market, for example Schrimpf et al. (2007) and Ziegler et al. (2007) also focus only on Frankfurt's top segment. While others, e.g. Wallmeier (2000), Amel-Zadeh (2011), Artmann et al. (2012b) do not distinguish between the

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21 In the U.S. most IPOs, especially of small firms usually take place at the NASDAQ, relatively few IPOs occur at the NYSE.

22 The market microstructure effect was first documented, but overestimated by Reinganum (1990) for the U.S. market. Loughran (1993) removes IPOs from his data set and shows that 2-2.5 % of the return differential between the NYSE and NASDAQ securities can still be attributed to a market microstructure effect.

23 Restricting the data set to the Amtlicher Markt in Frankfurt reduces the number of firms in the cross section. Compared to Artmann et al. (2012b) the size of our data set is on average 27.2 % smaller for the period from 1960 to 2006.

different market segments in their analysis.[24] Some, e.g. Elsas et al. (2003) do not even mention which market segments they consider.

2.4 Additional Peculiarities

2.4.1 Penny Stocks

We classify stocks whose share price is below €1.00 and whose market capitalization of the firm is less than €5 mln. as penny stocks. Some stock exchanges for example the NASDAQ, exclude penny stocks; stocks with a share price of less than $1.00.[25] The Deutsche Börse AG attempted to delist penny stocks from the Neuer Markt, but was not successful. Before 2001 our data set occasionally contains one penny stock at a time. However, from 2001 to 2007 the number of penny stocks averages 5.6% per year. The rate of return on penny stocks typically has a much higher standard deviation than the rate of return on stocks with higher prices, because minor price changes might yield rates of return of 100% or more. In addition prices of penny stocks are frequently manipulated. For these reasons, we do not include penny stocks when we group securities.

2.4.2 Tax imputation system (Körperschaftsteuergutschrift)

Dividend taxation traditionally is an important issue in Germany, since tax rates are high and capital gains were tax free until 2009. In Germany, both dividend payments and retained earnings are subject to the corporate income tax. In 1977, the corporate income tax amounted to 36% of pre-tax dividends. Traditionally dividend payments are also taxed by the personal income tax. As a consequence, between 1958 and 1977 and after 2000, dividends were subject to a 'double taxation'. From 1977 to 2000, the double taxation of dividends was eliminated for German shareholders. In addition to their 'cash dividend' they received a voucher from the tax authorities in the amount of the corporate income tax that was paid on their dividends (Körperschaftsteuergutschrift, corporate income tax credit). This voucher could be used to pay the personal income tax or to receive a tax refund.

From 1977 to 1993, the value of these vouchers was 9/16 (56.25%) of the cash dividend. As a consequence of the reduction of the corporate income tax rate to 30% it was 3/7 (approx. 42.86%) of the cash dividend from 1994 to 2000. In 2001 this "imputation system" ended. In the following years the double taxation of dividends was reduced by taxing dividends at the personal level at a rate that was only 50% of the regular income tax rate (half-income system, Halbeinkünfteverfahren).

If the Körperschaftsteuergutschrift is not included in the calculation of the rates of return of individual stocks or in the indices, the calculated return is equal to the after-tax return of an investor with a marginal tax rate of 36% (30% after 1994). Table 1 illustrates that dividend yields vary across size

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[24] The initial sample of Amel-Zadeh (2011) includes all CDAX firms between 1996 and 2006. Hence, his sample covers Frankfurt's Amtlicher Markt (1996-2006), Neuer Markt (1998-2003), and Geregelter Markt (1998-2006).

[25] See NASDAQ Stock Market Rules, Rule 4000 Marketplace Rules, The Bid Price Requirement, URL: http://cchwallstreet.com/nasdaq, October 14th, 2008. The SEC refers to penny stocks as "low-priced (below $5), speculative securities of very small companies." See URL: http://www.sec.gov/answers/penny.htm, August 12th, 2011.

portfolios. Large firms, on average, have higher dividend yields than small firms. Therefore by not including the tax credit for the corporate income tax on dividends between 1977 and 2001 has the same effect as not including the dividends in the rates of return calculation. On average the rates of return of large firms are biased downward to a greater extent than those of small firms. This would weaken a potential size effect or increase a reverse size effect.[26] Therefore, when testing the CAPM, we should include the Körperschaftsteuergutschrift.

2.4.3 Proxy for the Market Portfolio

Presently, the most prominent proxy for the German market portfolio is the CDAX (performance index), which has been published by the Deutsche Börse AG since April 22nd, 1993, the official start date. Until September 21st, 1998, the CDAX was based on Amtlicher Markt Frankfurt stocks only. Since then it also includes the stocks listed in the second segment of the Frankfurt stock exchange (the Geregelter Markt), which includes the leftovers of the Neuer Markt since 2003. During the time, in which the Neuer Markt was a separate segment, its stocks were also included (1998 to 2003). The Deutsche Börse AG also has made available a CDAX time series that covers the period from December 30th, 1987, to April 22nd, 1993.[27] From 1970 to 1988, the 'official' CDAX is based on the FWB-Index (Frankfurter Wertpapierbörse Index). According to Rühle (1991) the FWB-Index, like most indices at the time, did not take dividends into account. As a consequence, it underestimates the performance of German stocks from 1970 to 1988 by 3 to 4% per year.

Most studies on the German capital market that include time periods before 1988 apply either the DAFOX (available from 1960 to 2005), or the Stehle/Hartmond (SH-0%) time series (available from 1955 to 1988) as the market portfolio.[28] Both time series cover only the top segment of the Frankfurt exchange. We claim that for the purpose of our study the DAFOX does not represent a superior proxy of the market portfolio compared to the Stehle/Hartmond time series. First, from 1960 to 1974 the DAFOX does not contain all stocks of the Amtlicher Markt. Second, the DAFOX does not include the above discussed Körperschaftsteuergutschrift and therefore underestimates the performance of German stocks. However, both time series are not available for the full observation period of our study from 1953 to 2007. Therefore, we decided to calculate a monthly market value-weighted index for the Amtlicher Markt according to the methodology described in Stehle/Hartmond (1991).[29] Our time

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[26] See Stehle/Hartmond (1991) or Murphy/Schlag (1999) for more details about tax credits.

[27] The history of origin of this time series, especially its composition, is not documented to our knowledge. It may contain, for example, an ex-post selection bias.

[28] The SH-0% time series is documented in Stehle/Hartmond (1991). An updated version is available at www.wiwi.hu-berlin.de/finance. The SH-0% time series is based on the CDAX beginning in 1988. The DAFOX is documented in Göppl/Schütz (1995) and available from the Universität Karlsruhe. Among others Schlag/Wohlschieß (1997), Wallmeier (2000), Elsas et al. (2003), and Artmann et al. (2012b) use the DAFOX. The SH-0% time series is used by Schulz/Stehle (2002), Schrimpf et al. (2007), and Ziegler et al. (2007).

[29] Earlier studies like Black et al. (1972) and Fama/MacBeth (1973) use equal-weight market portfolios. Kothari et al. (1995) even argue in favor of equal-weighted market portfolios. However, most researchers as for example Fama/French (1996) argue in favor of value-weights. Grauer (1999) indicates that employing an equal-weight market portfolio might result in a size effect, even though the CAPM holds exactly.

series fully represents the Amtlicher Markt in Frankfurt for the time period from 1953 to 2007 and includes all financial benefits to stock holders.

3 Summary statistics and average portfolio returns

3.1 Summary statistics for size sorted portfolios

In this section we provide some insights into our data set and expand the discussion of some problems specific to the German market by looking at size sorted decile portfolios. A more detailed description of our data set is in Appendix A.[30] Following previous studies we form portfolios at the end of June of each year. We consider only non-financial firms for which a Dimson beta estimate is available and that have a positive book-to-market ratio as of the end of the fiscal year in t-1. This means that firms must have a minimum return record of at least 24 months before they are assigned to a portfolio. Firms with a negative book-to-market ratio and penny stocks that are not assigned to our portfolios at the end of June in year t are thus excluded for the period from July in year t to June in year t+1. Since we form portfolios on the firm level, no two portfolios contain a common firm at each point in time. The rate of return on the equity of a firm is calculated as the (market) value-weighted return of all of its share classes.[31] For the portfolios formed at the end of June in year t, we calculate the (post-ranking) monthly value-weighted and equal-weighted rates of return for the period from July in year t to June in year t+1.

Table 1 shows that the average number of firms per size decile portfolio decreases from 19 in 1960 to 16 in 1990. From 1990 to 2007, the number of firms per decile increases from 16 to 24 on average.[32] The number of firms per decile is relatively low compared to studies for the U.S. market where deciles usually contain more than 100 firms. This has to be considered in empirical tests, where we usually assume portfolios to be well diversified. Table 1 also reports that the market capitalization of the firms included in the portfolio of the largest firms is on average €9,981 mln. (in real terms based on the price levels of 2007), whereas the market capitalization of the smallest is on average only €19 mln. (also in real terms) from 1960 to 2007. The decile portfolio of the largest firms, labeled D10, accounts on average for ca. 70.7% of the total market capitalization of the Amtlicher Markt in Frankfurt (based on equal-weight portfolios), whereas, the firms in the first six deciles represent together only 5.7% of the total market capitalization.

[Table 1]

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30 In later sections we sort by size, book-to-market, and beta. We also form two-dimensional sorted portfolios based on these criterions.

31 We use the full time period of a firm's exchange listing. Artmann et al. (2012b, p. 23) "include only one class per firm in the sample and use the class for which the longer data history is available."

32 The sample size of Artmann et al. (2012b) increases more dramatically from 1990 to 2007. This is, because they also include lower market segments such as the Neuer Markt and the Geregelter Markt in Frankfurt.

In addition, Table 1 indicates that the average real firm size increases over time. The average real size of the smallest firms doubles from approximately €10 mln. in 1960 to €19 mln. in 2007, whereas the average size of the largest firms increases (almost by a factor of 7) from €3,991 mln. to 26,711 mln. within the same time frame. This means that the cross-sectional spread in portfolios' size increases over time, but also that a firm whose absolute size (in real terms) did not change from 1960 to 2007 is certainly assigned to lower size portfolios in later periods. The magnitude of the size variable also influences the magnitude of the coefficient on size in cross-sectional regressions. The Fama/MacBeth procedure allows the independent variables to vary over time. However, according to Chan et al. (1991) aggregating the coefficients from monthly cross-sectional regressions assumes that the distribution of the independent variables is stationary over time. This seems not to be the case for our size variable; size inhabits a heterogeneous time trend across portfolios. Hence if we have a regular size effect, we would expect a higher regression coefficient on the size variable in later months. We doubt that this effect influences the sign of the size coefficient, or that it accounts for the reverse size effect from 1990 to 2007.

Furthermore, Table 1 illustrates IPOs in the Amtlicher Markt in Frankfurt are neither evenly distributed among the 10 size-portfolios, nor in time. Few IPOs are allocated to the extreme portfolios D01 and D10. The number of IPOs in the Amtlicher Markt before 1980 is negligible (only 23). After 1980 we observe 197 IPOs, and on average 8 per year. Looking at the IPO distribution across portfolios is important, because Ljungqvist (1997), Stehle/Ehrhardt (1999), Sapusek (2000), Bessler/Thies (2007), and Pryshchepa/Stehle (2011) document a severe underperformance of IPOs in Germany within the first 3-5 years of their initial listing. The performance of portfolios with a higher number of IPOs might be more affected by IPO underperformance. However, we can report that our empirical results are not significantly affected by IPOs.

Table 1 also documents that the propensity to pay dividends has generally decreased between 1960 and 2007. We observe that a higher fraction, on average 93%, of the largest firms (D10) pay dividends throughout the period from 1960 to 2007. For the remaining size-portfolios the fraction of dividend paying firms declines considerably. There appears to be a positive relationship between size and the willingness/ability to pay dividends. In addition, we observe decreasing average dividend yields for most portfolios. However, dividend paying firms allocated to the small and medium size deciles, D01 to D08, actually increase their dividend payments on average by 25%. The reported decline in dividend yields for small firms in Table 1 mainly results from a decreasing fraction of firms that actually pay dividends. The different fraction of dividend paying firms and dividend yield across decile portfolios also point out that corporate income tax credits must be included in the rate of return calculation. Ignoring these benefits to share holders would penalize the performance of large firm deciles (higher fraction of dividend paying firms) compared to small firm deciles. As a consequence of missing dividends and/or missing income tax credits the chance to find a regular size effect increases.

3.2 Average returns for decile portfolios

This section is based on Table 3. We start by looking at the monthly excess returns in the top line of Panel A in order to see whether a size effect in raw returns exists. In the time period 1960 to 1990, the (arithmetic) means of the monthly excess returns of the three decile portfolios of the largest firms are around 0.20%, all other portfolios have mean excess returns higher than 0.33%. This holds for equal-weight and value-weight portfolios and is fully in line with a (regular) size effect in raw returns. Testing the null of flat or weakly increasing pattern in average returns across size deciles with the monotonicity relationship (MR) test of Patton/Timmerman (2010), we obtain p-values of 0.047 (comparing adjacent portfolios) and 0.186 (comparing all possible pairs) for equal-weight and of 0.138 (comparing adjacent portfolios) and 0.076 (comparing all possible pairs) for value-weight portfolios. Hence, there is some support for a regular size effect in raw returns during 1960 to 1990.[33] From 1990 to 2007, the five portfolios containing the firms whose size is above the median all have mean returns higher than 0.43%, the portfolio of the largest firms even has a mean return above 0.70%. The mean excess returns of the five portfolios of firms whose size is below the median are much smaller, and some are even negative. This suggests that a reverse size effect in raw returns may exist in this period. Again equal-weight and value-weight mean returns are very similar, this is what we expect when we sort on size. Testing the null of a flat or weak decreasing pattern in average portfolio returns during the second subperiod yields p-values for both versions of the MR test that are above .50 for equal-weight as well as value-weight portfolios. However, removing the portfolio of the smallest firms, D01, changes the results dramatically. The p-values are then all below 0.01. This supports the alternative hypothesis of a reverse size effect in raw returns during 1990 to 2007.

A notable exception is the equal-weight portfolio of the smallest firms in the period 1990 to 2007, whose mean return and standard deviation is much higher than that of the neighboring small firm portfolios and also considerably higher than the corresponding value-weight portfolio. This implies, that the smallest 8 to 10 firms in our sample from 1990 to 2007 have returns (1) that are relatively volatile and (2) have a relatively high arithmetic mean. The effect also seems to exist between 1960 and 1990, but less pronounced. At present, we cannot explain this return pattern. The return differential may be partly caused by the high standard deviation of the rates of return of this portfolio, which increases the difference between the arithmetic and the geometric mean. We typically look at the arithmetic mean, whereas the geometric mean is the more relevant number for long term investors. The stocks from the size decile portfolio containing the smallest firms makes up, on average, only 0.14% of the total market value of all firms in our sample. Given the high illiquidity and the small market capitalization of these stocks, they are usually not feasible portfolio candidates for institutional

33 Patton/Timmerman (2010, p. 609) argue that "[t]he adjacent pairs are sufficient for monotonicity to hold, but considering all possible comparisons could lead to empirical gains."

investors. With respect to these problems we exclude the firms of decile D01 (smallest firms) in all subsequent analyses except those that are based on the 10 size portfolios we presently look at.

When we look at the full time period from 1960 to 2007, the portfolio of the smallest firms has the highest mean return. Otherwise, portfolios containing firms with an above average size, on average, outperform portfolios containing firms with a below average size. Portfolios D05, D06, and D07 have higher returns than the three portfolios above and below it. Using the MR test, however, we cannot reject the null of a flat relationship in average returns across size portfolios.

We continue with an examination of raw (excess) returns of 10 portfolios sorted by book-to-market (see Panel C of Table 3). For the full period from 1960 to 2007 weighting does not make a big difference. However, when we look into the subperiods, especially from 1990 to 2007, weighting matters. From 1990 to 2007, we observe considerably higher average returns when we look at value-weight portfolios. For the portfolio of the firms with highest book-to-market the difference is 0.77% per month. This pattern could be attributed to the previously discussed reverse size effect in raw returns over the period from 1990 to 2007. We also observe that low book-to-market portfolios have on average lower returns than high book-to-market portfolios. This is observed for equal-weight as well as value-weight portfolios, in both subperiods and as a consequence in the full period. However, we also observe that the difference in average returns across portfolios is flat in some periods. For example, for the full period the average return of the equal-weight portfolios D02 is 0.28% and of portfolio D07 is 0.33%, there is, however, some variation in the average returns of the portfolios between these two portfolios.

The MR-test rejects the hypothesis of a flat or weakly decreasing relationship in average returns at a 5% level for the first subperiod from 1960 to 1990 in support of the alternative hypothesis of an increasing relationship in average returns. This result holds for equal-weight and value-weight portfolios, it also holds for the two alternatives of the MR test. The p-values for the second subperiod are all above 0.10, hence we cannot reject the null. For the overall period we can only reject the null looking at equal-weight portfolios; p-values are 0.057 (comparing adjacent portfolios) and 0.025 (all possible comparisons). We interpret these results in favor of a book-to-market effect in raw returns.

An inspection of the average excess returns of the 10 portfolios which result from beta-sorting in Panel C of Table 3 shows that the weighting of firms in a portfolio affects average returns dramatically. In the time period from 1990 to 2007, the portfolio consisting of the firms with the highest pre-ranking beta has a mean monthly return of 0.44% when the individual firms' returns are value-weighted, and -0.27% when these returns are equally-weighted. This implies that in this portfolio a small number of (very) large firms have relatively high returns, while a considerably larger number of firms have negative average excess returns. Large but less dramatic differences also show up when we compare other portfolios. In the first subperiod from 1960 to 1990, equal-weight portfolios have generally higher returns compared to their value-weight counterparts. This would be in line with a regular size effect during this period. In the second subperiod, however, the value-weight portfolios have all higher average returns compared to their equal-weight equivalents. This would be in line with the above documented reverse size effect in raw returns.

A visual inspection of the average portfolio excess returns in Panel C of Table 3 shows, that the returns in the first subperiod are more in-line with the CAPM than those in the second period. The MR-test, however, does not reject the null hypothesis of a flat relationship in any of the periods we look at.

4 Major issues in applying the standard test procedures

4.1 Basic aspects of the standard test procedures

There has been a considerable progress in empirical tests of the CAPM since the first such efforts in the sixties. Yet, to our knowledge, there is no general agreement with regard to the proper test procedure. Therefore, we follow the most widely used procedures for testing linear beta pricing hypotheses, the analysis of individual time-series regressions proposed by Black/Jensen/Scholes (1972) [BJS], the cross-sectional regression procedure proposed by Fama/MacBeth (1973) [FM] and the multivariate time-series regression test of Gibbons/Ross/Shanken (1989) [GRS].[34] Since the three procedures are based on different assumptions and test objectives, and look at the time-series of cross-sectional data in different ways, we consider them as ideal complements to each other, especially when the same set of test portfolios are used, which we plan to do.

BJS tests examine whether the average returns of portfolios are in line with the CAPM (or a competing model). Important assumptions of this procedure are:

- We have a proper proxy for the market portfolio, that is (1), the composition of the market portfolio is known, and (2), the data to measure/estimate the market portfolio's return is available. Roll (1977), in a widely quoted paper, argued that this is not the case and discussed the serious consequences of not using a proper proxy.[35]
- Based on Equation (1) the test portfolios have stable alphas and betas during the test period.
- A risk-free asset exists.
- The error terms from Equation (1) are normally distributed, serially uncorrelated and homoskedastic.

If the CAPM holds we expect BJS intercepts (also known as Jensen's alpha), α_i, to be zero for all test assets. An assumption about the functional form of the relationship between beta and Jensen's alpha is

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[34] All three procedures are discussed in detail in advanced text books such as Campbell et al. (1997), Cochrane (2005), and Elton et al. (2011). Recent review articles covering these tests are Fama/French (2004), Subrahmanyam (2010), Jagannathan et al. (2010) and Goyal (2012).

[35] A proper proxy has the same return distribution and is perfectly correlated with the true market portfolio.

not required. This relationship could be linear or non-linear. Because of infrequent trading issues we use a variation of the original BJS procedure, i.e. we estimate portfolio intercepts from a model extended by the lagged market excess return when we use monthly data:

$$R_{i,t} - R_{f,t} = \alpha_i + \beta_{i,1}\left(R_{m,t} - R_{f,t}\right) + \beta_{i,2}\left(R_{m,t-1} - R_{f,t}\right) + \varepsilon_{i,t} \tag{1}$$

where $R_{i,t}$ is the rate of return of portfolio *i* during time interval *t*, $R_{f,t}$ is the risk-free rate of return, $R_{m,t}$ is the return on the proxy for the market portfolio during period *t*, $\varepsilon_{i,t}$ is the error term of portfolio *i* in period *t*.[36] We use the standard BJS procedure for quarterly and annual data.

BJS look only at the t-statistics of individual portfolios. An important result of the BJS test could be that one or more portfolios have an economically or statistically significant non-zero Jensen's alpha. According to Gibbons et al. (1989) such a result is difficult to interpret due to the contemporaneous cross-sectional dependence between the residuals of different portfolios. They observe especially, that residuals of portfolios with similar betas are positively correlated, those with very different betas are negatively correlated. Since the alphas of the portfolios will inhabit the same pattern, it is difficult to conclude whether a pattern in the alphas is due to correlation in the residuals or the true parameter.

To overcome this problem we use the multivariate procedure of Gibbons et al. (1989) to test whether all intercepts are jointly equal to zero, that is, we use it as an extension of the BJS tests. The GRS test does not require assumption (a) (we have a proper market proxy). However, it requires assumptions (b) to (d) [37], and in addition assumptions (e) and (f):

- The number of test assets is smaller than the number of time series observations.[38]
- The variance-covariance matrix of the residuals is stationary during the test period.

If assumption (a) (we use a proper proxy for the market portfolio) does not hold, the test tells us, whether the proxy used is ex post mean-variance efficient when we use portfolios which were constructed on the basis of ex ante data to derive the efficient frontier. Under this aspect the GRS-test is an ideal complement of BJS and FM.

A crucial question in the implementation of a BJS- or a GRS-test is the proper length of the test periods. Using a longer test period increases the power of the test. It also increases the probability that the stationarity assumptions (b), (d) and (f) are violated, which has consequences for the test statistics and are difficult to evaluate. We will get back to this issue in Section 3.7 and 3.8. In view of the uncertainty about the proper length of the test periods we do BJS- and GRS-tests for 60 months, our two subperiods, 7/1960 to 6/1990 and 7/1990 to 10/2007, and the full period from 7/1960 to 10/2007.

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[36] We adjust standard errors for heteroscedasticity and autocorrelation following Newey/West (1994).

[37] In the absence of a risk-free asset, we could test the zero-beta CAPM. In this case, however, the null hypothesis is no longer linear in the parameters. Finally, we cannot apply the standard GRS test in this case. See Gibbons et al. (1989).

[38] The residual variance-covariance matrix has to be nonsingular. Usually *N* (the number of test assets to be tested) is restricted by the number of observations *T*, whereas the choice of *T* is a question of stationarity.

The FM procedure also requires assumptions (a), (proper proxy for the market portfolio). Betas may vary over time, unless we use full period betas. However, the FM procedure implicitly assumes that pre-ranking betas are informative for next period betas and that betas are stationary during the period for which we estimate the pre-ranking beta and during the subsequent test period. Several recent studies of the FM procedure focus on its power. Grauer/Janmaat (2009) argue that the FM procedure lacks power to reject the null hypothesis of a zero slope on beta. Murtazashvili/Vozlyublennaia (2012) conclude that the FM procedure is less likely to reject the null if the CAPM almost holds, that is, if pricing errors (alphas) are small, but negatively correlated with betas.

Nevertheless, FM regressions may help us to identify anomalies, by including several independent variables in the regression model. Like all linear regressions, FM assumes that the relationship between the dependent and the independent variables is strictly linear. Our full FM-regression model follows Fama/French (1992), it includes beta, size, and book-to-market as independent variables:

$$R_{i,t} - R_{f,t} = \gamma_{0,t} + \gamma_{1,t}\left(\beta_{i,t}\right) + \gamma_{2,t}\left(Size_{i,t}\right) + \gamma_{3,t}\left(BM_{i,t}\right) + u_{i,t} \tag{2}$$

where $R_{i,t}$ is the rate of return of portfolio/firm *i* during time interval *t*, $R_{f,t}$ is the risk-free rate of return, $\gamma_{0,t}$ is the intercept for period *t*, and $u_{i,t}$ is the error term of portfolio/firm *i* in period *t*.

The crucial difference between the FM procedure and more traditional cross-sectional regression procedures is that the regression is ran for each period. The time series of coefficients is used for hypothesis testing, that is, the time series of coefficients is used to calculate the average coefficients and the standard deviations of the average coefficients. This has several advantages compared to traditional cross-sectional regression procedures: Unbalanced panels do not create problems, betas may vary over time and, most importantly, in any time period *t* the $u_{i,t}$'s may be cross-correlated.[39] We also test variations of this model, i.e. we use subsets of the independent variables in Equation (2).

Even though, the BJS, FM and GRS tests represent the most important basic test procedures, the possible variations in these three procedures inhabit several problems. In the literature these problems are usually examined one at a time. Finding an "optimal" test procedure is, however, less apparent if several problems occur at the same time. The standard econometric problems which complicate tests of the CAPM are the omitted variable problem, the unknown true functional form of the relationship to be tested, serial autocorrelation, multicollinearity and heteroscedasticity. In addition, problems occur which are related to the special nature of the CAPM and the available data. The latter problems and their implications for our tests will be discussed in the next sections:

- Should the tests be based on monthly, quarterly or annual data (Section 4.2)?

[39] Goyal (2012) discusses the differences between the traditional cross-sectional procedures and the FM procedure in great detail, especially on page 13.

- Should we use data on individual firms or base our tests on portfolios (Section 4.3)?
- How should we form the portfolios in the latter case (Section 4.4)?
- Should small and large firms be treated equally in our tests (Section 4.5)?
- How should the betas be calculated (Sections 4.6)?
- Beta instability and its consequences for the test procedures (Section 4.7).
- The economic interpretation of the three test procedures (4.8).

We are aware of the fact that we cannot address all problems of CAPM tests. For example, what we do not address are tests of conditional asset pricing models and (multi-) factor models.[40]

4.2 Return interval

Most empirical tests of the CAPM are based on monthly rates of return. Some, as for example Kothari et al. (1995), Fama/French (1996) and Campbell/Vuolteenaho (2004), employ annual rates of return.[41] Only a few studies, like Campbell/Vuolteenaho (2004) and Avramov/Chordia (2006),[42] employ quarterly data. Kothari et al. (1995) provide three reasonable arguments in favor of annual data: (1) the CAPM makes no assumption about the investment horizon, (2) problems associated with low liquidity, and infrequent trading are less severe, and (3) annual data mitigates problems related to anomalies such as the turn-of-the-month (year) effect and the January effect. Even though annual data may reduce problems related to seasonal effects, it cannot fully solve these problems.[43] In addition, we expect fewer problems to be caused by serial correlation for longer interval returns, especially with respect to small firms.[44] Stein (1996) provides an additional argument in favor of longer-horizon returns. He argues that in an inefficient stock market, observed returns are subject to market-wide noise. As a consequence of this pricing error, firms' beta estimates will be biased. However, in case of stationary market-wide noise the beta estimate will converge to β^*, "the unobserved beta" (given investors have rational expectation) if longer horizon returns are employed.[45]

There is obviously a tradeoff between the mentioned effects and the larger amount of observations associated with the use of monthly data, which we cannot quantify. We alternatively use monthly, quarterly and annual return data in our empirical tests.

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40 See Lewellen et al. (2010) and Daniel/Titman (2012) for a more detailed discussion of factor model tests.

41 Kothari et al. (1995) use annual betas (from the regression of annual portfolio rates of return on an equal-weight market portfolio) in their monthly FM regressions.

42 Avramov/Chordia (2006) use quarterly data in their tests of the CCAPM because consumption data is available on a quarterly basis only. Most of their tests of the CAPM and the 3 factor model are, however, based on monthly data.

43 An alternative approach to account for seasonal patterns as the January effect is to remove January observations or to look at them separately as Loughran (1997) and Stehle (1997).

44 Serial correlation in short interval returns yields downward biased risk estimates. This problem and possible solutions have been discussed in the literature among others by Scholes/Williams (1977), Dimson (1979) and Roll (1981). Looking at longer return intervals (monthly, quarterly, and annual) partly mitigates problems with serial correlation. In Section 4.6 we discuss the Dimson procedure, which accounts for serial correlation and infrequent trading when estimating betas.

45 Using a longer observation period (e.g. 25 years) with monthly data may also solve the problem Stein describes. We are not aware of empirical evidence supporting the extent of Stein's basic argument.

4.3 Individual firm vs. portfolio data

Studies that employ portfolio data in cross-sectional regressions use an argument introduced by Miller/Scholes (1972) and Blume/Friend (1973): security betas cannot be observed, even if we have a proper proxy for the market portfolio, but must be estimated, typically with historical rate of return time series. The estimated beta may be interpreted as the sum of the true beta and an estimation or measurement error. In a two-variable linear regression measurement errors in the independent variable lead to downward biased (towards zero) estimate of its coefficient and an upward biased (away from zero) estimate of the intercepts in cross-sectional regressions.[46] The reduction of the bias caused by the measurement errors in the betas associated with the use of portfolio data has been the major reason for using portfolio data, at least until the 1990s. Black et al. (1972) argues that the measurement error in betas decreases for sorts on betas, whereas groupings on other criterions or random grouping of securities does not necessarily reduce the measurement error in betas.

To overcome the measurement error in the betas, securities (in our study firms) are usually first grouped by the betas estimated on the basis of data (usually 60 months) preceding the portfolio assignment date (pre-ranking betas). Next, the portfolio data for the subsequent test period is analyzed econometrically; in a first step, the portfolio betas for the test period are calculated (post ranking portfolio betas). Given that the measurement errors are imperfectly correlated across securities within a portfolio, post-ranking portfolio betas are estimated more precisely than individual security betas.[47] However, it is also important that the measurement errors in the pre-ranking betas and the post-ranking portfolio betas are uncorrelated. Huang/Litzenberger (1988) point out that this assumption usually holds.

Fama/French (1992) recognize the problem of measurement error in the beta. They argue that beta estimation may be improved with portfolio data, but suggest to use individual firm data (including the beta estimates based on portfolios) in the FM regressions.[48] Ang et al. (2010) show that the procedure of Fama/French (1992) yields the same results as the Fama/MacBeth (1973) procedure with equal-weight portfolios and beta as the only independent variable. This we confirm in our empirical tests.[49] Furthermore, Grauer/Janmaat (2004) argue that Fama/French (1992) regression results vary with the applied sorting procedure; different results are obtained when portfolios are first sorted by size and

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[46] This is also pointed out by Black et al. (1972). Artmann et al. (2012a) regress securities rates of return on individual securities' OLS betas in their cross-sectional analysis. We conclude, that their beta estimates probably underestimate the systematic risk of most firms, especially of small firms. Additionally, given the results of Black et al. (1972), we expect their slope coefficients to be downward biased.

[47] An alternative to grouping to reduce the measurement error has been advocated by Litzenberger/Ramaswamy (1979). Instead of grouping securities by their beta they use the measurement error in beta to derive consistent estimators (weighted least squares), that is, they put more weight on more reliable beta estimates in the cross-section of security returns.

[48] Another approach is taken by Brennan et al. (1998) who use risk adjusted rates of return of individual firms in FM regressions to overcome the measurement error in betas.

[49] In a world where there is no measurement error, Grauer/Janmaat (2004) point out that securities do not plot along the security market line when equal-weight portfolio betas are assigned to individual securities in the cross-section. They also note that the market portfolio is super-efficient if equal-weight portfolio rates of return are employed.

then by beta compared to sorting first by beta and then by size. We also observe different cross-sectional results if we switch the sorting order.

To our knowledge, in empirical studies the univariate time-series test of BJS and the multivariate time-series tests of GRS are only done on the basis of portfolio data.

Grouping may also be motivated by the associated reduction in the number of test assets, which facilitates computations and the interpretation of the results. In addition, only a fraction of firms exists over longer time periods. New stocks are introduced through IPOs, and existing stocks are delisted because of acquisitions, mergers, bankruptcies and freeze-outs, that is, our data set on individual firms is an unbalanced panel. According to Blume/Friend (1973) grouping generally mitigates this (de-)-listing problem and in addition smoothes extreme rates of return of individual securities.[50] Depending on the study design, the use of portfolios may allow the inclusion of a specific firm during more time periods than in case of the use of data on individual firms. For example, a security may be included immediately after the IPO when we form size portfolios. When using data on individual firms, the rates of return on the IPO firm can only be included once a return record of at least 24 months is available to calculate the beta of the firm. Also, the assumption of stationary betas and expected excess rates of return over time is also more likely fulfilled for grouped data than for individual securities. This is an important assumption underlying the BJS and GRS tests, but also of the FM tests with full-period betas. Another reason for the use of grouped data may simply be restricted access to firm data, whereas portfolio data might be easily available to a researcher.[51]

If we group firms into portfolios, how should we do it? The choice of the grouping procedure is typically based on the null hypothesis to be tested. In our context, the following H_0-hypotheses play a role:

- H_0: the coefficient of beta is zero, that is, beta does not affect expected rates of return.
- H_0: the CAPM holds exactly: all pricing errors are zero.
- H_0: a size effect in raw returns does not exist (or book to market effect).
- H_0: the CAPM holds and a size effect in risk-adjusted returns does not exist (or book-to-market effect).

In addition the grouping procedures should not result in portfolios, which violate the stationarity assumptions of the test procedure. For example, grouping by criterions other then beta does not

[50] Since the standard estimators are based on the squared residuals, outliers may have a large effect on the estimates. Alternatively, outliers could be winsorized or removed from the sample. We carefully cross-checked all unusual observations/outliers. In addition, we primarily focus on value-weight portfolios. Therefore, we neither remove nor winsorize returns or firms' explanatory variables as for example in Fama/French (1992) and Artmann et al. (2012b). However, even winsorizing the top and bottom 5% changes our results only marginally.

[51] French's data library (at http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html) provides easy access to data for various portfolios, not only for the U.S. but also for many other countries. Portfolio data for the German market is available from the website of the Centre for Financial Research Cologne (CFR) (http://www.cfr-cologne.de).

necessarily yield stationary portfolios betas.[52] This is an aspect we think is very important and, as a consequence, is carefully discussed in Sections 4.7 and 4.8.

If beta is the only independent variable in a FM regression and the H_0-hypothesis is “the coefficient of beta is zero” where “beta does not affect the expected rate of return on assets” then we should choose a grouping procedure that minimizes the measurement error in betas and maximizes the dispersion of the betas across test assets. BJS (1972) were the first to suggest to group securities by their betas in a prior time period.[53] Fama/French (2004) and Jagannathan et al. (2010) conclude that this has become the standard procedure since BJS. Lo/MacKinlay (1990) also argue in favor of the test procedures introduced by BJS that is, sorts on beta.

Different grouping procedures are appropriate, when we test whether average returns are related to anomaly variables such as firm size, book-to-market, and momentum,[54] that is, when we test the null hypotheses “the coefficient on size” and/or “the coefficient on book-to-market” is zero.[55] These indirect tests of the CAPM, therefore, typically group by the anomaly variables on which they focus.[56] Since Fama/French (1993) sorting on size and then on book-to-market (forming 5x5 portfolios) has become the most common grouping procedure.[57] However, according to Lo/MacKinlay (1990) grouping by anomaly variables like size and book-to-market are solely induced by empirical findings, grouping by beta is a theoretically grounded procedure.

4.4 Problems of grouping

Huang/Litzenberger (1988, p. 330) conclude “that grouping always results in a loss of efficiency.” Ang et al. (2010) examine carefully whether individual securities or portfolios should be used in cross-sectional tests. They warn that more precise estimates of betas for portfolios do not necessarily translate into more precise estimates or lower standard errors of the coefficients on beta. This problem is caused by a loss of information in the independent variable (like beta, size, or book-to-market). Grouping reduces the cross-sectional dispersion in the independent variable. As a consequence the standard error of the slope coefficient increases, which decreases efficiency of slopes on portfolios compared to individual securities. According to Huang/Litzenberger (1988) groups must be formed in a way in which the dispersion in the inter-group independent variables is maintained as much as

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52 Ang/Chen (2007), for example, show a remarkable variation in betas of portfolios sorted on book-to-market across time.

53 Among others studies, Black (1993), Fama/French (1992), Kothari et al. (1995) and Fama/French (2004) also group securities by their beta. Several studies as for example Davis (1994) group securities into portfolios by pre-ranking betas to estimate post-ranking portfolio betas which they assign to individual firms as proposed by Fama/French (1992). Most studies do not just group by one criterion as for example by beta, but also by other criterions.

54 French’s data library (http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html) contains various portfolios, all sorted on anomaly variables like size, book-to-market, etc., none sorted on betas.

55 Another branch of the empirical literature started by Daniel/Titman (1997) test whether characteristic or factor models explain stock returns. In these test securities are usually grouped by size and then by book-to-market. Next, these groups are further subdivided according to firms’ factor loadings, HML or SMB, resulting in three-dimensional grouping.

56 Among others Davis (1994), Davis et al. (2000), and Ang/Chen (2007) group firms by book-to-market. An overview of studies that sort by firms’ size is provided by Dijk (2011).

57 Among others this grouping procedure is applied by Fama/French (1993, 1996, 2011), Loughran (1997), Davis et al. (2000), Petkova/Zhang (2005), and Lewellen/Nagel (2006).

possible to minimize the loss in efficiency. For sorts on beta, the post-ranking portfolio betas should also approximately reproduce the sort of the pre-ranking betas.

Another problem is that grouping by a variable that is subject to measurement error results in groups that depend on the measurement error. Liang (2000) argues that grouping might aggregate the measurement error of the variable used to form groups. Hence, it would be unclear whether an independent variable adds to the cross-section of stock returns because of a correlation between the variable itself or its measurement error with returns. As a consequence, groups should be formed using a criterion that is independent of the measurement error but highly correlated with the true value of the independent variable. In Section 4.6 we indicate that sorts on OLS betas yield groups where the measurement error is not independent of the true beta.

Lo/MacKinlay (1990) emphasize that grouping according to an empirically motivated variable, like size, might yield misleading inferences. They refer to this problem as a data-snooping bias. They conclude that the correlation between Jensen's alpha and size in the U.S. might be a result of the correlation between size and the measurement error in alpha. According to Lo/MacKinlay (1990) induced ordering will probably affect test statistics on portfolios, whereas test statistics on individual securities are less affected. Our out of sample tests based on size sorted portfolios are not subject to the data-snooping bias.

Similarly, problems arise if the number of variables used to form groups is less than the number of independent variables employed in the FM regression. A common example would be the test of Fama/MacBeth (1973) where beta, the square of beta, and residual risk are employed as independent variables in cross-sectional regressions on portfolios' mean rates of return. The test portfolios were solely grouped on firms' betas, but not on firms' residual risk. The results of their empirical tests suggest that residual risk is not priced. However, this result might be induced by the chosen sorting procedure and therefore just by chance. A common procedure to overcome this problem is to group securities first by one variable and second to subdivide the groups by another variable which results in dependent two-dimensional sorts. Generally, groups should be formed taking all independent variables into consideration. The main challenge here is restricted data availability, more groups translates into less securities per portfolio and at some point portfolios might contain too few or no securities. Groupings solely based on anomaly variables yield low inter portfolio spread in portfolio betas. As a consequence, FM tests will lack efficiency with respect to the slope on beta.[58]

The choice of the number of test assets is also quite important. To elaborate, FM tests gain efficiency for the slopes with an increasing number of portfolios. [59] Increasing the number of portfolios results in

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[58] Grauer/Janmaat (2009) show that sorts on size and book-to-market do not result in a wide range of betas. As a consequence cross-sectional tests of whether the coefficient on beta is zero lacks power. They also introduce an interesting procedure to increase the spread in beta, and hence to increase the power of empirical tests.

[59] Black et al. (1972) form 10 portfolios, whereas Fama/MacBeth (1973), and Fama/French (1992) form 12 portfolios, and Kothari et al. (1995) form 20 portfolios in order to test the CAPM.

less diversified portfolios and hence reduces regression fits.[60] This also affect the precision of intercepts in BJS time-series regressions. The GRS test requires, due to non-singularity issues, the number of test assets to be smaller than the number of time series observations less the number of factors. The GRS test, however, is more powerful if the number of portfolios is kept small. Gibbons et al. (1989) recommend that the number of test assets for which the variance-covariance matrix is estimated, should be less than a third to one half of the number of time periods. According to Campbell et al. (1997) GRS tests are more powerful if the number of groups is close to 10.

Gibbons et al. (1989) also argue that the power of the GRS test is not invariant to the way we group securities. According to Sentana (2009) the GRS test will have little power if securities are grouped randomly. He argues that this is caused by a low inter-group variance in information ratios. Furthermore, he argues that grouping by firm characteristics such as size and book-to-market produce disperse inter-group information ratios, whereas industry groups have similar information ratios. Grouping procedures that increase the inter-group information ratios increase the power of the test compared to individual securities.

4.5 Equal-weight vs. value-weight portfolios

The CAPM should generally hold for individual securities, as well as equal-weight and value-weight portfolios. When we try to verify/reject it, a crucial question is: how should we evaluate deviations of individual stocks/firms from the security market line (pricing errors)? When we use data of individual firms or equal-weight portfolios with an identical number of firms per portfolio, we implicitly assume that all individual deviations should be weighted equally. When using value-weight portfolios, we implicitly assume that the deviations associated with larger, that is economically more important firms, should carry a larger weight than the deviations associated with smaller firms.[61] In addition, larger firms are rarely pure-play firms. Typically they consist of a parent company and subsidiaries that is they are conglomerates. Equal-weight portfolios implicitly assign a smaller weight to a firm if it operates as a subsidiary of a larger firm than to an otherwise identical, but free-standing and exchange-listed firm.

An additional benefit of value weighting is that observations for which the probability that they contain a data error is higher, receive a smaller weight. Even in a high quality data set, data of dividends, stock splits and rights issues of small firms may be a little bit less accurate than the data on large firms. More important, as we will elaborate in Section 4.6, betas for small firms and/or portfolios of small firms are generally underestimated because of infrequent trading and low liquidity.

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[60] Our data set for the Amtlicher Markt in Frankfurt contains on average only 192 firms per year. Forming more than 20 groups, thus results in groups with less than 10 firms per group, on average.

[61] Buying stocks according to their market share is an implementable and theoretically motivated investment strategy. This strategy results in (market) value-weight portfolios. Alternatively an investor could allocate his wealth across N stocks, where each stock represents 1/Nth of his portfolio. This portfolio must be rebalanced at the beginning of each observation period, implying high transaction costs. This strategy also implies buying past losers and selling past winners.

A related question, especially for sorts on size, is: should we assign an equal number of observations to portfolios? If we assign a larger number of firms to portfolios of small firms, this will decrease the implicit weight of the firms in those portfolios and as a consequence in the empirical tests. In most studies on the US market, this is achieved by assigning AMEX and NASDAQ securities to portfolios according to NYSE "breaking points". In general, AMEX and NASDAQ stocks have a relatively low market capitalization. Therefore, U.S. small stock portfolios contain more stocks than large stock portfolios.[62] We hesitate to include stocks of other market segments or from other stock exchanges into our analysis, primarily because in Germany a market segment effect may exist.Most studies on the cross-section of stock returns employ equally-weighted portfolio returns. Exceptions we are aware of include Daniel/Titman (1997), Loughran (1997), Fama/French (2004), Ang/Chen (2007), and Fama/French (2008). Two of these studies use equal-weight as well as value-weight portfolios. Loughran (1997) reports that the spread between average returns of high and low book-to-market quintiles drops from 6.23% for equal-weight portfolios to 3.93% for value-weight portfolios. Furthermore, Loughran (1997) argues that book-to-market does not explain returns of large stocks.[63] Fama/French (2008) compare equal-weighted and value-weighted returns of micro, small and large firm portfolios from the NYSE-Amex-NASDAQ universe. They find that returns differences are generally largest within the micro firm portfolio.[64] In some cases the differences are even quite substantial within large firm portfolios. Hence, we would expect regression results to vary with the weighting procedure, even when we look at sorts on size. Fama/French (2008) estimate separate regressions for microcaps, small stocks, and big stocks. They conclude that the size effect is more pronounced for microcaps, whereas returns associated with book-to-market are more consistent across size groups.

Blume/Friend (1973) argue that value-weighted returns are conceptually preferable to equal-weighted returns. However, they also warn that regression estimators from value-weight portfolios may be less efficient and probably more subject to measurement errors in the independent variables. This problem generally depends on the portfolio composition. In Germany, the independent variables of value-weight portfolios are dominated by a few large firms, especially if we do not sort on size. Hence, the portfolio beta, and especially its measurement error, is dominated by a few large firms. Later we show that the betas of large firms are measured more precisely, hence benefiting the portfolio betas. Grauer/Janmaat (2004) warn that in a world without measurement error the CAPM might appear correct, even though it is false when value-weighted portfolio rates of return are employed.

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[62] See for example Fama/French (1992, 1993), and Daniel/Titman (1997). Fama/French (2011) explain that this sorting procedure avoids sorts being dominated by small and less important, but plentiful stocks.

[63] Loughran (1997) finds FM regression results on size and book-to-market to vary across NYSE, Amex and NASDAQ firms. He observes a significant book-to-market effect for NYSE stocks in January only, whereas for Amex and NASDAQ firms the effect appears outside January only.

[64] Fama/French (2008) argue that there is a size effect within the micro firms, whereas tinier firms have higher average returns. They also argue that the size effect is weaker for small and big firm firms.

We observe for our groups on firm size, that the market capitalization of the largest firms is on average €10 bln. (in real terms), whereas the market capitalization of the smallest firms is on average only € 19 mln. (in real terms) from 1960 to 2007 (see Table 1). Decile D10, which includes the largest firms, represents on average 70% of the overall market capitalization of the Amtlicher Markt, whereas, deciles D01 to D06 represent together less than 6%. Similar observations have been made for the U.S. for example by Loughran (1997) and Fama/French (2008).[65] This means that approximately 6% of the overall market capitalization of the Amtlicher Markt is implicitly assigned a weight of roughly 60% in cross-sectional regression analyses based on individual firms or size sorted portfolios. As a consequence, regressions estimated on all firms are heavily dominated by small firms. This is an important issue since anomaly returns might not be pervasive across size groups, but only within certain groups as indicated above.

Our data set also contains many stocks with a market capitalization of less than €100 mln. (see Table 1). OLS beta estimates of small stocks are generally systematically downward biased as indicated below. We doubt that the Dimson procedure fully accounts for this measurement error. Hence, the assumption that measurement errors are imperfectly correlated across securities within a group is certainly violated. Small stocks, especially those with low free-float, are also more subject to unusual return patterns. These unusual patterns usually affect returns of equal-weight portfolios (unless portfolios contain many securities), even though they are difficult to exploit by an investor.

Another aspect is how do we estimate the independent variables of portfolios' characteristics like size and book-to-market? We are currently not aware of any paper that addresses this issue. We are not sure if all papers that use value-weight portfolios also apply value-weighted size and book-to-market as independent variables.[66] When we look at value-weighted portfolio returns, we use portfolios' value-weighted independent variables. This is especially important when portfolios consist of few very large firms and many very small firms. We observe such portfolio compositions when we sort firms by their pre-ranking betas and book-to-market ratios. The value-weighted returns of these portfolios are dominated by few large firms, whereas the equal-weighted independent variables, as for example, firm-size would be dominated by the many small firms. As a consequence, we would try to establish a linear relation between the returns of large firms with size variables, which are dominated by small firms. This could affect regression coefficients in an arbitrary manner.

Using different weights for small and large firms may be desirable economically. The standard econometric procedures do not provide easy ways to do this. To our knowledge, no study based on

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[65] Loughran (1997) reports that his largest size quintile represents on average 73% of the total market capitalization during 1963 to 1995. Fama/French (2008) state that micro caps represent ca. 3% of the market cap of the NYSE-Amex-NASDAQ universe, whereas they account for more than 60% of the firms during 1963 and 2005.

[66] We estimate portfolios' value-weighted size and book-to-market ratios as Daniel/Titman (1997). We follow Kothari et al. (1995) when we calculate the natural log of the average independent variables size and book-to-market. Daniel/Titman (1997) describe a way to estimate value-weighted size and book-to-market ratios for portfolios. However, since they focus on time-series regressions, they do not employ them as independent variables in cross-sectional regressions. In Appendix A, we explain how we estimate the independent variables in more detail.

individual firm data gives larger firms a greater weight than smaller firms. Fama/French (1992) for example use individual firms in their cross-sectional regressions and thus give extremely small firms the same weights as extremely large firms. It could be argued that small stocks are given too much weight in their study and hence drive the results.[67] We also do regressions based on individual firm data, but for this reason, give the results only limited weight when we arrive at our over-all conclusions. We address issues related to small firms placing less weight on those firms, simply by employing value-weight portfolios. We also analyze equal-weight portfolios to check whether our value-weight results are robust.

4.6 OLS vs. Dimson betas

Obviously, firm size and trading activity are highly correlated, whereas small firms are usually less frequently traded. Roll (1981) concludes that because of positively serially correlated returns, risk measures like standard OLS beta (and standard deviation) obtained from short interval return data seriously underestimate the actual risk of small sized firms.[68] This makes it difficult to compare risk adjusted rates of return across different sized firms, since performance measures as Jensen's alpha, the Treynor ratio and the Sharpe ratio are probably overestimated for small sized firms, especially if they are obtained from short interval returns. Serial correlation is not only a problem in daily, but also in monthly returns. We observe decreasing serial correlation, indicated by variance ratios, for our size sorted portfolios (not reported).[69] Returns from one-dimensional sorts on beta and book-to-market are also subject to this issue. This is an important issue in Germany since Table 1 indicates that most German firms are tiny in terms of market capitalization.

Fama/French (1992) address this issue by estimating firms' pre-ranking sum betas, according to the procedure proposed by Dimson (1979). They regress firms' rates of return on the current and one-period lagged market return using 24 to 60 (as available) monthly observations. They show for size-sorted portfolios that the difference between monthly post-ranking OLS betas (simple betas) and Dimson betas increases from -0.03 (largest stocks) to 0.31 (smallest stocks) as firm size decreases. We observe similar results for German firms (not reported). We estimate pre-ranking and full-period Dimson betas following Fama/French (1992, 1996). Betas of firms that have multiple share classes listed in the Amtlicher Markt at the same time are estimated using value-weighted rates of return over all share classes of that firm.

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67 Loughran (1997) argues that the results of Fama/French (1992) are driven by "a January seasonal in the book-to-market effect, and exceptionally low returns on small, young, growth stocks." Kothari et al. (1995) argue that the results by Fama/French (1992) are exaggerated by a survivorship bias in the COMPUSTAT data. However, Chan et al. (1995), Fama/French (1996), and Chou et al. (2009) point out that a survivorship bias cannot affect the relationship between average rates of return and the book-to-market ratio for U.S. securities.

68 Roll suggests that underestimated risk measures for small firms may explain the firm size effect. However, Reinganum (1982) concludes that parts but not all of the firm size effect can be explained by underestimated risk measures.

69 We calculate variance ratios dividing the variance from annual returns by the annualized variance of monthly returns. If stock returns follow a random walk, the annual standard deviation should be about $\sqrt{12}$ times the monthly standard deviation. For a detailed discussion see Lo/MacKinlay (1988), which provide also a variance ratio test procedure.

McInish/Wood (1986) suggest that the Dimson estimator does not fully adjust for the beta bias due to infrequent trading. Kothari et al. (1995) propose to use OLS betas from annual return intervals in monthly cross-sectional regressions to overcome thin trading problems. In comparison to Fama/French (1992) they reveal a stronger positive relationship between annual betas and average returns. However, Fama/French (1996) argue that these results are probably attributed to an equal-weighted instead of a value-weighted market portfolio.[70] Nevertheless, we also employ annual betas as part of our robustness checks. There are at least two more problems with respect to beta estimates. First, if the market portfolio is not efficient, beta might not represent a good measure of a firm's systematic risk at all. Second, we show in Section 4.7 that small changes in the average betas of large firms go together with large changes in the average betas of small firms, i.e. they are negatively correlated.

Nevertheless, we believe that the Dimson beta is a superior estimate of firms' (and portfolios') systematic risk and therefore, produces a better ranking of firms according to their systematic risk than standard OLS betas. OLS betas result more likely in a sort of size. Table 2 demonstrates that the composition of beta sorted portfolios varies considerably with the beta estimation technique. Only 34.3% of the firms are allocated to the same portfolio using firms' Dimson betas instead of OLS betas. This difference is smaller for the extreme portfolios (lowest and highest betas).

We also observe that the coefficient on the lagged market excess return is positive and statistically significant for all equal-weight portfolios (see Table 2). For value-weight portfolios the coefficients are statistically significant only for the two lowest beta portfolios, D01 and D02. This result is caused by the large number of small firms, which dominate the returns of equal-weight portfolios and translates into downward biased OLS beta estimates. Value-weight portfolio returns are less affected by this bias as indicated by the lower values of the lagged coefficients. For the value-weight portfolios only the lagged coefficients for D01 and D02 are statistically significant, possibly because of the higher number of small firms assigned to these portfolios. This is indicated by a lower average market capitalization for the low beta portfolios compared to the other portfolios (see Table 1).

[Table 2]

Table 2 also indicates that the difference between Dimson and OLS betas of Dimson beta sorted portfolios increases in beta. This suggests that the measurement error increases in the betas when we accept the Dimson beta as a better estimate of the true portfolio beta. The assumption that the measurement error is uncorrelated with the true beta (classical errors-in-variables problem) is not fulfilled. As a consequence the slope on OLS portfolio betas in FM regressions will be biased. Finally, Table 2 shows that the standard errors of the OLS beta for our value-weight portfolios resembles the

70 Grauer (1999) shows in Table 1 how regression results change when an equal-weight instead of a value-weight market portfolios is used. Even though the CAPM is true, a size effect emerges when an equal-weight proxy is employed.

standard errors of the OLS beta of our equal-weight portfolios. The standard error slightly increases for equal weight portfolios, whereas it is almost flat for value-weight portfolios.

4.7 Time varying portfolio betas

Figure 1 illustrates the variation of 5-yr post-ranking rolling Dimson betas for size sorted portfolios during the period from 1960 to 2007.[71] The beta for the portfolio of the largest German firms (bottom graph in Figure 1, solid line) varies within the rather narrow range of 0.87 (just before the subprime crisis) and 1.22 (just before the dot-com bubble burst). The range of the betas of the lower size portfolios is more than twice as large, it is from 0.31 to 1.15 for medium sized firms (D05) and from 0.25 to 1.19 for the smallest firms (D01). This shows that in Germany there is more variation in the betas of small firms compared to large firms (this is generally in line with the U.S. market (top graph in Figure 1)). The betas of small firms are generally lower than those of large firms (this is opposite to the U.S. market, where these betas are generally higher).[72] In both markets the inter-portfolio spread of the betas of the ten size portfolios also varies considerably over time. In Germany, it ranges from 0.16 in September 1962 to 0.96 in November 2000. The portfolios containing the smallest firms do not always have a lower beta than the portfolio of the largest firms in Germany. Neither do the portfolios of the smallest firms always have a higher beta than the portfolio of the largest firms in the U.S.

The value-weighted sum of all size portfolios' betas plus the beta of the financials should be unity on average. This implies that small changes in the betas of the largest firms go together with large changes in the betas of the smallest firms in the opposite direction. Figure 1 illustrates this relationship for the U.S. market using Ken French's value-weighted size sorted portfolios. From July 1962 to July 1970, the beta of the portfolio of the largest U.S. firms decreased nearly continuously by a total of .08 (from 1.00 to 0.92). In the same time interval, the beta of the portfolio of the smallest firms almost doubled from 1.16 to 1.94. From July to November 1974, the beta of the portfolio of the largest firms increases by 0.05, and the beta of the portfolio of the smallest firms decreases by -0.36. A major source for the variation in portfolios' and firms' betas over time is simply induced by the constitution of the market portfolio, which is dominated by large firms, and the mechanics of beta estimation. As a consequence of the variation in portfolios' betas, results from the BJS and GRS test for size portfolios need to be interpreted with caution. Both test procedures implicitly assume portfolio betas to be stationary over time. Gibbons et al. (1989) propose to address this issue by subdividing the sample into five year intervals assuming that betas are stationary over this shorter time period.

[Figure 1]

[71] The discussion of time varying betas starts with Blume (1971) and Baesel (1974), a recent study for German stock data is Eisenbeiss et al. (2007).

[72] Studies for the US market revealed an inverse relationship between firm size and beta, i.e. portfolios' post-ranking betas are decreasing in average portfolio size. See Fama/French (1992), Kothari et al. (1995).

Another noteworthy aspect in Figure 1 is the beta of the portfolio of financial firms which consists largely of Germany's exchange listed universal banks and insurance companies. Typically (and especially since 2003) these firms have the highest betas. Notice that financials are represented by our market portfolio, but not by our test portfolios.

4.8 Problems with the GRS test

We briefly introduced the GRS test in Section 4.1. Gibbons et al. (1989) also present a very 'intuitive' geometric interpretation of the GRS test where the Sharpe ratio of the market portfolio, $\hat{\theta}_M$, is compared to the Sharpe ratio of the optimal ex post tangency portfolio, $\hat{\theta}_P$. The optimal ex post tangency portfolio is a combination of all test portfolios and the market portfolio, *M*. Under the null both Sharpe ratios do not differ considerably. The larger the difference between the two Sharpe ratios the more likely the GRS test rejects the null. We find the maximum ex post Sharpe ratio of the tangency portfolio solving a classical portfolio optimization problem. The input parameters to this problem are the returns of the *N* test portfolios, the market portfolio *M*, the risk-free asset and the combined covariance matrix of the *N* test assets and *M*. Solving this optimization problem yields insights into the composition of *P* implied by the GRS test. Implicitly, the GRS test makes no assumption regarding short positions in *P*.[73] In addition to *P,* we construct a portfolio P_{nS} under the assumption that short sales are not allowed. In Figure 2, we present the solution to these optimization problems using our size decile portfolios.

For the period from 1960 to 2007 the GRS test does not reject the CAPM, the p-value is .2625. However, the implicit weights of most test portfolios to derive *T* are quite remarkable, e.g. we would need to short the market portfolio by 140%. In addition, the annualized average return of *T* from July 1960 to October 2007 is ca. 19%. Given an average risk-free rate of 4% would yield a market risk premium of 15%, compared to 4% based on the market portfolio. During the first subperiod from 1960 to 1990, where we observe a regular size-effect, we weight the market portfolio with 18% only. We short the three portfolios containing the largest firms (weights are -143%, -70% and -12% for the largest), which together represent on average ca. 80% of the total market capitalization. However, based on the GRS test, p-value of 0.31, we cannot reject the CAPM. The GRS p-value for the second subperiod from 1990 to 2007 is 0.04, i.e. we can reject the CAPM at a 5% significance level. The weights for most size portfolios are either very low, or very high. We would short the market portfolio with -557%(!), as well as portfolio D02 (-799%!) and D03 (-681%!). The three largest portfolio holdings with positive weights are D06 (608%), D10 (459%) and D08 (385%). The resulting tangency portfolio, *P*, has an average annualized rate of return of approximately 40%.

These portfolio compositions are obviously not maintainable; the weights are unrealistic and vary considerable over time. Assigning positive weights to the test assets and the market portfolio to derive

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[73] We assume a maximum investment of 10 times the initial investment, i.e. weights may range from -1,000% to +1,000%.

the tangency portfolios would probably be a more realistic assumption. Under this assumption we trace out P_{nS} weighting D06 with 51%, D08 with 26% and D10 with 23% for the second subperiod. The p-value of 0.99 suggests that the difference between the Sharpe ratio of the P_{nS} and M is not statistically significant. However, the composition of the tangency portfolio is not very encouraging; most portfolios including the market portfolio have zero weights. Levy/Roll (2010) overcome this issue modifying the returns and variances of the test assets (within their estimation error bounds), showing that the market portfolio can be efficient. They also show that the risk free rate of return can also influence the results heavily. Increasing the risk free rate of return (by using another proxy) could lead to even lower rejection rates when testing the efficiency of our market proxy.[74]

We find many applications of the GRS test in the literature for time periods of 30 years or even longer.[75] For such long time periods the assumption of normal i.i.d. residuals may be violated. GRS suggest applying their F-test for five year intervals, because of stationarity concerns. For our aforementioned size-sorted decile portfolios (as well as other sorts), however, we can easily reject the null hypothesis that the residuals from the BJS regressions for the full period or the two subperiods are normal i.i.d. using standard test procedures. Affleck-Graves/McDonald (1989) conclude that although the GRS test is reasonably robust for minor deviations from normality, it can substantially understate the actual significance level in case of large deviations from normality. As a consequence of non-normality of the residuals the power of the GRS test will be overstated and the p-values of the GRS test statistic will be too low. The robustness of the GRS test decreases with the level of the non-normality in the residuals. This may account for low p-values in empirical tests, and as a consequence increase the probability to mistakenly reject the null hypothesis. We implement the GRS test for our full-period, 7/1960 to 10/2007, and the two subperiods, 7/1960 to 6/1990 and 7/1990 to 10/2007, as well as non-overlapping five year intervals.

5 Results

In this section we sort on size and book-to-market (one-dimensional sorts) to explore whether these two variables are potential candidates of anomaly variables. Furthermore, we group firms by their pre-ranking beta to test the CAPM directly. We also highlight results for two-dimensional sorts on size and book-to-market. For one-dimensional sorts we generally present results for deciles; however, as part of our robustness checks, we also form 16 and 20 one-dimensional sorted portfolios. For two-dimensional sorts we primarily focus on 4 by 4 sorts, we check the robustness of our results looking at 2x2, 3x3, 5x5, and 6x6 sorts. Furthermore, we check whether empirical results depend on the sorting order, i.e., does sorting by size and then by book-to-market yield different results as sorting first by

[74] We use the one month money market rates reported by Frankfurt banks as our proxy for the risk-free rate of return.

[75] The GRS test is applied for periods longer than 30 years among others by Fama/French (2006) for the period 7/1926 to 12/2004 (942 months) and two subperiods, from 7/1926 to 6/1963 (444 months) and from 7/1963 to 12/2004 (498 months); Ferguson/Shockley (2003) for 7/1964 to 12/2000; Fama/French (1996) for 7/1963 to 12/1993 (366 months).

book-to-market and then by size? In addition, we do not only look at monthly return data (excess returns), but also at quarterly and annual return data. We use monthly, quarterly and annual full-period betas, but also monthly and quarterly rolling betas as independent variables in our FM tests. We generally stress results for value-weight portfolios, but also present results for equal-weight portfolios. For value-weight portfolios we estimate value-weighted size and book-to-market variables. We follow the same pattern for equal-weight portfolios. We look at the full time period from 1960 to 2007, but also at two subperiods. The first subperiod extends from July 1960 to June 1990, the second from July 1990 to October 2007.

5.1 Results based on one-dimensional sorts

5.1.1 Sorts on firm size

In Section 3.1 we focused on one-dimensional sorted size-portfolios to present the main characteristics of the firms in our data set. In Section 4, we illustrated that sorts on size inhabit several problems. (1) Cross-sectional results for sorts on size are dominated by small firms. (2) The results for beta lack efficiency in cross-sectional FM tests. (3) The results for book-to-market also lack efficiency. (4) The betas of size portfolios have undesirable properties. Thus it remains unclear whether a size effect prevails once other independent variables are added to the model. Nevertheless, many papers on the cross-section of stock returns conduct empirical tests for size-sorted portfolios. An important reason supporting this procedure is that sorts on size allow us to draw conclusions about the existence of a market-wide size effect in raw returns. In addition, the weighting of the intra portfolios' rates of return has the least influence on the results when we sort by size.

Compared to the results (average returns) for size sorted portfolios in Section 3.2, we obtain even stronger results in favor of a size effect when we use FM cross-sectional regressions in which excess rate of return is used as the dependent and size as the only independent variable (see Table 8). In the first subperiod (1960-1990) the coefficient on size (more exactly the natural logarithm of size) is negative, but not significant in all of our 22 regressions with data sets that differ with respect to weighting, return interval, number of portfolios, and the inclusion of portfolio D01 (smallest firms). In the second subperiod (1990-2007), the coefficient on size is always positive, and is economically and statistically highly significant in the 22 comparable FM regressions (reverse size effect). It is mostly positive, but never significantly so in the overall period. The intercepts also have a systematic pattern across the three observation periods: they are strongly positive (economically and statistically significant) in the first sub period, negative and not quite as strong in the second subperiod, and slightly positive in the overall period.

In the next step we run 44 FM regressions that include beta in addition to size as an independent variable (results not shown). These regressions differ with respect to the number of portfolios, the return intervals, and the way portfolio betas are estimated. Compared to only using size as an independent variable this changes the coefficients on size and the related t-values in the following way: (1) In the first subperiod most coefficients remain practically the same. There is a tendency that in the regressions based on annual data the coefficients are a bit more negative and their t-statistics a bit higher; for equal weight portfolios they are close to being significant. When we employ rolling or annual full period beta estimates in the regressions based on monthly or quarterly data, the t-values are typically higher and for equal-weight portfolios often statistically significant. (2) In the second subperiod, the coefficient is often a bit larger and generally highly statistically significant. (3) For the overall period, most FM test variations yield positive and statistically insignificant coefficients on size. In these 44 FM regressions the coefficients on beta are typically positive in the subperiod from 1960 to 1990, especially when we use annual data, betas based on annual data or rolling betas. With these, the associated t-values are on average around 1.00. In the second subperiod, the coefficients on betas are typically negative, in the overall period they are mostly negative, and in both periods they are nearly always statistically insignificant.

When we include book-to-market in addition to size as an independent variable we observe in all of the 22 FM regressions the following characteristics for the coefficients on size (results not shown): (1) always negative, but statistical insignificant in the first subperiod. (2) Always positive, and statistically significant for equal-weight portfolios. (3) The reverse size effect in the second subperiod is stronger when we increase the spread of the size variable by forming 16 or 20 size portfolios instead of ten. (4) Positive, but insignificant in the overall period. The characteristics of the book-to-market coefficients are the same in all three observation periods: (1) always positive and statistically significant when we use twenty portfolios, (2) positive, but not significant if we use only 16 or 10 portfolios.

Adding both beta and the book-to-market in addition to size as independent variables does not yield new insights on the size effect. In fact, due to the high correlation between size and beta, and size and book-to-market, we would expect higher standard errors of the estimated coefficients as soon as we include more than one independent variable. Here, we also do not sort by beta or book-to-market, which results in low inter-portfolio spreads for these variables. Nevertheless, even though we look at size sorted portfolios, the book-to-market effect emerges in our data set and appears to be statistically significant in some variations of the test procedure, especially as we increase the number of size sorted portfolios from ten to twenty.

Despite the problems caused by non-stationary betas (see Section 4.7 and Figures 1 and 2), we proceed with BJS time-series tests where we focus on Jensen's alphas. BJS allows us to identify the portfolios that deviate most from the CAPM prediction for a specific period. The results for size sorted decile portfolios are in Panel A of Table 3. In the first subperiod (1960-1990) when we look at either equal-weight or value-weight portfolios, we observe negative or near neutral (annualized) Jensen's alphas for the three largest size portfolios, and positive alphas for the seven portfolios containing smaller firms. Most t-values are not significant. In the second subperiod (1990-2007) an even stronger reverse size effect prevails. The top five deciles of the largest firms all have positive alphas, whereas the small firm portfolios, except for the smallest firm decile, have negative alphas. Again, most t-values are not significant. This effect is economically so strong that we also observe a reverse size effect within the full period. Here, none of the t-values are significant. As in the analysis of raw returns, the results indicate that size related effects are not stable within our overall sample period.[76] Again, the performance of portfolio D01 deviates considerably from its neighboring portfolios: the annualized Jensen's alpha is nearly 8 to 10 percentage points higher than that of portfolio D02.

We also test whether the CAPM explains the returns of size sorted portfolios using the GRS test. The results are in Table 6 (Panel A). In general, the GRS test statistic tends to be significantly lower for value-weight portfolios. Only in the second subperiod (1990-2007), where we observe an economically strong reverse size effect, do the GRS test statistics reject the CAPM on a 5% level. We can neither reject the CAPM for the first subperiod nor for the overall period based on the p-values in Table 6. Looking at annual data of size sorted portfolios for the full period results in Jensen's alphas that are similar to the corresponding annualized alphas resulting from monthly or quarterly data. However, the GRS p-values for annual data are well above 0.80, for monthly and quarterly data they are .40 on average. As a consequence, we cannot reject the CAPM in the full period when we look at size portfolios. These results are quite robust to variations in the procedure: weighting, number of portfolios, and return interval (monthly, quarterly, annual). Our decision to remove the portfolio of the smallest firms, D01, does not influence the results for the GRS test considerably.[77]

We can reject the null hypothesis that the residuals from the BJS regressions are normally distributed. In the Section 4. 8 we argued that as a consequence of non-normality in the residuals, the power of the GRS test will be overstated and the p-values of the GRS test statistic will be too low. The bias increases with the level of the non-normality of the residuals. This may account for the low p-values for the second subperiod, where we reject the null that the CAPM holds on a 5% level. In other words, the rejection of the CAPM in the second subperiod could be simply due to non-normal i.i.d. residuals. The GRS results are also sensitive to the number of portfolios, especially for the second subperiod. Using 16 portfolios instead of 10 yields p-values of 0.05 (EW) and 0.11 (VW) for the GRS test, whereas 20 portfolios yield considerably lower p-values of 0.01 (EW) and 0.01 (VW).[78]

We address the problem induced by non-stationary portfolio betas by dividing the overall period into five year, non-overlapping intervals. For each interval we apply the GRS test. The results are in Table 7.5 (Panel A). Aggregating the GRS coefficients yields average p-values well above 0.26 for our two subperiods (1960-1990 and 1990-2007) as well as for the overall period. This result is independent to the weighting scheme as well as the number of portfolios (10, 16, 20). Only for the 5-yr interval from

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76 Several authors document a reversal of the size effect. Dimson/Marsh (1999) report a reversal of the size effect for the U.S. and the UK markets. Earlier studies on the size effect such as Blume/Friend (1974), Brown et al.(1983), and Blume/Stambaugh (1983) also report that the size-effect is non-stationary across subperiods.

77 Including portfolio D01 yields lower GRS p-values, especially for equal-weight portfolios.

78 This result is probably caused by the low number of firms per portfolio which is on average less than 10 .

2000 to 2005 we observe p-values that are generally below .05 and close to zero. For all other 5-yr intervals the p-values are usually above 0.10. This means that based on size sorted portfolios we could reject the CAPM only for the period from 2000 to 2005.[79]

Taken together, the FM analysis of the excess returns of the portfolios grouped on the basis of size shows: (1) between 1960 and 1990 a moderate size effect in raw returns may exist, between 1990 and 2007 an economically strong and statistically significant reverse size effect in raw returns exists. (2) BJS and GRS tests do not support these results for the first subperiod, but show clear signs for a reversed size effect in the second subperiod, especially during the time period between 2000 and 2005. The results differ for the number of portfolios and the weighting procedure used. (3) Weighting does not matter much when we group according to size, (4) the firms in size decile portfolio D01 have returns that differ considerably from the returns of neighboring portfolios and (5) the alphas in the first subperiod are fully in line with a risk-based explanation of mean returns, so are the alphas in the overall period. The results for the second subperiod may be caused by the special nature of this period, especially with respect to the period from July 2000 to June 2005.

5.1.2 Sorts on book-to-market

We start by looking at our 22 FM regression results in Table 8 for book-to-market sorted portfolios. In the first subperiod there is a economically and statistically strong book-to-market effect. It is a bit more pronounced, economically and statistically, for equal-weight portfolios than for value-weight portfolios. In the second subperiod the effect is smaller, especially when we weigh equally. In the full period, based on FM regressions using only book-to-market as an independent variable, the effect is economically and statistically significant. The FM results are robust to the weighting procedure; however, the t-values for equal-weight portfolios are a bit lower compared to those for value-weight portfolios in the second subperiod. We obtain similar coefficients on book-to-market and its t-values when we test regression models extended by beta and/or size (results not shown).

In Panel B of Table 3 we present BJS and GRS results for monthly decile portfolios sorted by book-to-market. These results are more subject to weighting. In the first subperiod (1960-1990), for example, we observe positive and statistically significant Jensen's alphas for the top two book-to-market portfolios when we look at equal-weight portfolios, whereas for value-weight portfolios only the top portfolio's alpha is positive and statistically significant. The alphas of the four bottom portfolios are generally negative in this subperiod, but only for the bottom (D01) value-weight portfolio is it statistically significant. Altogether, seven of the equal-weight portfolios' alphas are positive, whilst only three of the value-weight portfolios are positive. This observation might be closely related to the above discussed regular size effect in this period. The GRS results also differ considerably for the first

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[79] During this period our market portfolio suffered a loss of ca. 55% (from July 2005 to April 2003), afterwards it increased by ca. 84% in value (from April 2003 to July 2005).

subperiod. Looking at equal-weight portfolios yields a rejection of the CAPM with a GRS p-value of 0.02, whereas for value-weight portfolios we cannot reject the CAPM with a p-value of 0.23.

In the second subperiod (1990-2007), the alphas for the three value-weight portfolios with highest book-to-market are economically and statistically significantly positive, the annualized alphas are ca. 7%. The alphas for the same equal-weight portfolios are close to zero, on average ca. 0.5%. None of the alphas of the equal-weight portfolios are statistically significantly positive. In addition, we find now eight alphas for value-weight portfolios that are positive, whilst only four for the equal-weight portfolios are positive. This may reflect the strong reverse size effect in this subperiod. As a consequence, it is difficult to conclude whether there is a book-to-market effect among large firms, even though there is a tendency that alphas and excess returns increase with the book-to-market ratio. For the equal-weight portfolios we find no relationship between alphas (and excess returns) and book-to-market. This implies that there is no book-to-market effect among small firms. The GRS p-values also differ considerably for the second subperiod, 0.45 (EW) vs. 0.08 (VW).

During the full period (1960-2007), weighting has almost no effect on the results of the BJS and GRS tests. The alphas of the bottom portfolios, D01, are significantly negative, and of the top portfolios, D10, significantly positive. A visual examination reveals that alphas and average excess returns are increasing in book-to-market. The GRS p-values are practically zero in the full period for both types of weighting, 0.04 (EW) vs. 0.02 (VW). These results for the BJS and GRS tests should be considered with caution. Figure 4 illustrates that the portfolio betas of the book-to-market portfolios vary considerably over time and are not stationary for most book-to-market portfolios.[80] As a consequence, the assumption that the residuals from the BJS regressions are normal i.i.d. is hardly fulfilled. The p-values for the full period may therefore be too low. Notice that we can neither reject the CAPM based on a GRS test in the first subperiod (p-value of 0.23) nor for the second subperiod (p-value of 0.08) looking at value-weight portfolios.[81] This casts some doubt on the low p-value for the overall period of 0.02.

Using annual data yields similar Jensen's alphas compared to the annualized values based on monthly data. The GRS p-values for the full period, however, increase considerably, from 0.04 to 0.20 (EW) and from 0.02 to 0.25 (VW). We can also not reject the CAPM when we average GRS p-values from five year intervals for our two subperiods (1960-1990 and 1990-2007) and the overall period (1960-2007). The average p-values are (independent of the weighting) well above 0.3 for all three periods (see Panel A of Table 7). Similar, the p-values for the five year periods are generally well above 0.1. Only the p-values for the five year period from July 2000 to June 2005 are mostly below 0.1. This holds for equal-weight as well as value-weight portfolios. This means that based on the GRS test we

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80 Similar patterns have been revealed for the U.S. Ang/Chen (2007) also report remarkable drifts (downward trend for low book-to-market stocks) in rolling OLS betas for their portfolios sorted on book-to-market.

81 To provide another example, for 16 value-weight book-to-market sorted portfolios we obtain GRS p-values of approximately 0.17 for the first and the second subperiod, but only of 0.02 for the full period.

could only reject the CAPM on a 5% significance level for the period from July 2000 to June 2005, but not for any of the other 5-yr intervals from 1960 to 2007.

To sum it up, the results from the FM regressions tests and the BJS tests lead to similar, but not identical results. Based on book-to-market sorts, we can identify a book-to-market effect in both subperiods and the full period. The GRS test does not support these results fully.

5.2 Direct tests of the CAPM based on beta sorts

BJS show that under standard assumptions (see Section 4.1) CAPM tests should be based on portfolios constructed by sorting on beta, a procedure that was also followed by FM. In this section we follow their arguments and sort on pre-ranking Dimson betas. Before we present test results, we look at the rolling betas of beta sorted decile portfolios and their variation over time (see Figure 5). The graphs show that these betas vary considerable over time for most portfolios and even increase/decrease considerably within short time periods. As a consequence of the tendency that the betas of financial firms increase during our sample period, most portfolio betas inhabit a downward trend over the full-time period, especially from 1990 to 2007. Perhaps as a consequence of this instability, we observe that the order of the pre-ranking portfolio betas is not exactly reproduced by the post-ranking betas.

In addition, we find periods in which the betas of many firms decrease considerably at the same time (see Figure 6). For example the number of firms with a beta less than one increases from 100 (ca. 53% of the firms) in 1997 to 140 (ca. 70% of the firms) in 1998 and further to 208 (ca. 82% of the firms) in 2002. This means that a firm with a beta of one is allocated to a higher beta portfolio in 2002 than in 1997, not because its beta changed, but because the betas of the other firms changed. As a consequence the post-ranking portfolio beta is probably too high and therefore, less informative for the returns of the firms within the portfolio. This problem is caused by the constitution of our proxy for the market portfolio, which is dominated by few very large firms. As shown in Section 4.7 small increases in the betas of large firms go together with large decreases in the betas of small firms, and vice versa. Therefore, our results for the BJS and GRS tests have to be considered with caution.

We start by presenting the results for the BJS tests (see Table 3, Panel C). In the first subperiod from (1960-1990) we observe that two out of ten equal-weight beta portfolios have significantly positive Jensen's alphas and two alphas are nearly significant. None of the value-weight portfolios have a statistically significant alpha on the 5% significance level. We observe five negative alphas for value-weight portfolios and only one for equal-weight portfolios. Still, the associated p-values for the GRS test do not differ considerably, 0.28 (EW) vs. 0.30 (VW). In the second subperiod (1990-2007), the highest beta equal-weight portfolio has an economically and statistically highly significant annualized alpha of -10.86%, while the corresponding value-weight portfolio only has a Jensen's alpha of -2.24%, which is not statistically significant. Furthermore, we observe negative alphas for the three equal-weight portfolios with the highest betas. Only two of the corresponding value-weight portfolios have negative alphas. In addition, we find three positive and highly statistically significant value-weight alphas, whilst none of the positive equal-weight alphas are significant. These differences seem to be caused by the strong reverse size effect in this subperiod. The GRS p-values of 0.03 (EW) and 0.04 (VW) reject the CAPM on a 5% level.

Comparing the alphas from both subperiods with each other, we observe that the alphas of the three highest beta equal-weight portfolios switch their signs from positive in the first to negative in the second subperiod. This is not the case for the corresponding value-weight portfolios. The sign of the alpha for the lowest beta portfolio changes for both weighting schemes from negative to positive. The switch in signs of the alphas of the equal-weight portfolios could also be attributed to the size effect. In the first subperiod, we observe a weak regular size-effect, where small firms have positive alphas. In the second subperiod, when we observe a strong reverse size effect, small firms have negative or lower alphas. As a consequence the portfolio alphas vary over time.

When we look at the full time period (1960-2007), the seven equal-weight low beta portfolios all have positive alphas, while the three portfolios with a high beta all have negative alphas. These results could indicate that the Black (1972) version of the CAPM holds in Germany. In addition, three out of ten alphas are statistically significantly different from zero on a 5% significance level. The resulting GRS p-value of 0.04 rejects the CAPM at a 5% significance level. The results for the corresponding value-weight portfolios are no cure to the CAPM. For the full period the alphas are positive for most value-weight portfolios. They are negative for the lowest beta portfolio and two of the three high beta portfolios. Three of the seven positive alphas are statistically different from zero. This also translates into a GRS p-value of 0.04 for the overall period.

In conclusion, we cannot reject the CAPM based on the GRS test for value-weight or equal-weight beta sorted portfolios for the first subperiod from 1960 to 1990. For the second period, however, the null that the CAPM holds is rejected on a 5% significance level. For the full time period we would also reject the CAPM on a 5% significance level based on the GRS test. However, most of the underlying assumptions of the test procedure are violated. Portfolio betas are not stationary. The BJS residuals are not normal i.i.d. As a consequence of the non-normality of the residuals, the power of the GRS test is probably overstated and the p-values of the GRS test statistic too low. We find that the CAPM cannot be rejected by the GRS test for most 5-yr periods. Rejections generally occur only for the period from 1990 to 1995 and from 2000 to 2005. Table 7 also shows that the average 5-yr p-values for the two subperiods and the full period are well above 0.1.

Our FM tests provide further evidence in favor of the CAPM. Again, we observe that in cross-sectional regressions weighting matters. We would draw very different conclusions looking at average slopes on betas obtained from equal-weight vs. value-weight portfolios. Equal-weight portfolios yield slopes that are generally positive in the first subperiod, generally negative in the second subperiod, and mostly negative in the overall period. The slopes on beta are, however, not statistically significant. This observation does not change when we try to increase the spread in post-ranking portfolio betas by forming 16 or 20 portfolios instead of 10. The results are also stable with respect to the return interval (monthly, quarterly, annual), the procedure to estimate post-ranking betas (full period, rolling) and whether we look at firm or over-portfolio data.

For value-weight portfolios, we obtain, with some exceptions in the second subperiod, positive slopes on beta in all periods. This result is robust to all of the above mentioned variations in the FM test procedure. However, the slopes are not statistically significantly different from zero. This issue causes some authors to conclude that the CAPM is dead. Grauer/Janmaat (2009) conclude that such statements "may be greatly exaggerated" because cross-sectional "tests of whether the slope is equal to zero lack power".[82] They also argue that tests of a zero intercept are informative for value-weight portfolios.[83] The alphas for our value-weight portfolios are not statistically different from zero for the full period. The same applies to the first subperiod, most t-values are very close to zero. In the second subperiod, however, the alphas are generally positive and statistically different from zero. When we increase the number of portfolios from 10 to 16 and 20, the t-value on alpha decreases. For twenty beta portfolios only few of the alphas from value-weight portfolios are statistically significant. For equal-weight portfolios, however, a different picture emerges. The alphas are generally positive in all periods. They are generally statistically significantly different from zero in the second and the overall period for 10, 16 and 20 portfolios. Taking all of this together (the results and the empirical problems), we interpret our cross-sectional results as further evidence in support of the CAPM, especially for large firms.

The results for the slopes on betas are quite robust to an omitted variable bias, i.e. adding size and/or book-to market does not change slopes on beta. The slopes are generally positive in all periods and for most variations when we look at value-weight portfolios. For equal-weight portfolios the slopes are positive in the first period only, whereas, they are generally negative in the second subperiod and the full period. With respect to alphas, we observe that adding one additional independent variable generally yields higher alphas in the first subperiod; alphas are generally lower for the second subperiod and the full period. Extending the model, by both size and book-to-market, does not change the results for beta (see Table 9). The slope on beta remains generally positive in all periods when we look at value-weight portfolios. Some are statistically significant in the first and second subperiod. The alphas for the value-weight portfolios are mostly positive in the first subperiod. In the second and full period they are generally negative. The corresponding t-values are, however, usually close to zero in all periods. Some annualized alphas range between 10% and 22% in the second subperiod. None of them are significant however. This is probably caused by high residual variance in this subperiod. For

[82] They also indicate in their Table 4 that results differ with respect to equal-weight and value-weight portfolios. Rejecting the null of a zero slope is less likely for equal-weight portfolios.

[83] Grauer/Janmaat (2009) show that for value-weight portfolios rejection rates for zero intercepts are down to 5% for 360 and more observations. For equal-weight portfolios, however, rejection rates increase as the number of observation increases. Hence such tests might incorrectly indicate that the CAPM should be rejected.

the equal-weight portfolios, we observe generally negative slopes on beta in the second period and as a consequence frequently negative slopes in the full period. The alphas are generally positive in all three periods. Few alphas are statistically significant. We also observe that the coefficient on book-to-market is generally positive in all three periods and sometimes even statistically significant. We are aware of the fact that we did not sort by the two mentioned anomaly variables. Therefore, the results for size and book-to-market are inconclusive. We will try to fix this issue in the next section.

To sum it up, when we sort purely on beta, that is we follow the recommendation by BJS and others, the results for the FM tests (where we use beta as the only independent variable) are in line with the CAPM regardless of the weighting in the first subperiod. During this subperiod the intercepts, while being mostly positive, are never statistically significant. In the second period, rejections of the CAPM occur more often. When we sort on beta and use value-weight portfolios the results for the full period, 1960 to 2007, are fully in line with the CAPM. The slopes on beta are positive, not statistically significant though. The intercepts are also not statistically different from zero. The results change dramatically when we look at equal-weight portfolios. Now, the slopes on beta are mostly (insignificantly) negative, and the intercepts are (significantly) positive. GRS test results for the subperiods and the full period might be inconclusive because of the time variation in betas. Looking at p-values for 5-yr intervals, the CAPM is rejected mainly in the periods from 1990 to 1995 and from 2000 to 2005.

5.3 Tests based on two-dimensional sorts on size and book-to-market

In this section we extend our previous discussion of market-wide size and book-to-market effects in German returns by looking at double sorted portfolios, first by size and then by book-to-market, or vice versa. From our point of view, two-dimensional sorts on size and book-to-market inhabit two severe problems. First, we do not sort on beta. Therefore, the inter portfolio spread in portfolio betas, especially for equal-weight portfolios, is rather small (see Table 4). For value-weight portfolios the maximum spread in full-period betas over the full period is 0.54, 0.52 for the first subperiod, and 0.53 for the second subperiod. As a consequence the efficiency of the slope on beta in cross-sectional tests is low. Second, the procedures of BJS and FM (where we use a full-period beta) assume stationary portfolio betas over time. Figure 7 indicates that this assumption is violated for our value-weight double sorted size, book-to-market portfolios. Rolling beta estimates for these portfolios vary considerably over time, most portfolio betas even exhibit a downward trend. The variation in beta of small firms is considerably higher than for large firms.

We start by looking at the results for our FM regressions in Table 10 where we use beta, size and book-to-market as independent variables.[84] We address the problem of time varying betas by additionally using rolling betas. There is a clear tendency for a regular market wide size effect within

[84] These results are supported by a reduced model where only size and book-to-market enter as independent variables.

the first subperiod. The sign of the coefficient on size is negative in all variations of the FM test procedure (return interval, beta estimation, weighting, number of portfolios). The effect is not statistically significant when we look at 4x4 sorts. An attempt to increase the intra portfolio spread in size by looking at 5x5 sorts, yields mostly statistically significant coefficients on size. When we further increase the spread in size by looking at 6x6 sorts, yields coefficients on size that are again mostly statistically insignificant. The coefficient on size is also not statistically significant for firm level data. Nevertheless, our results for the first subperiod support Stehle's (1997) conclusion that a regular size effect existed in Germany before 1990.

We draw a completely different picture for the second subperiod, the slope on size is negative and statistically significant for almost all variations in the test procedure. A strong reverse size effect prevails. The annualized coefficient on size is on average almost 3% (with a range of 2–4%). The reverse size effect in the second subperiod is strong enough to manifest into the overall period. For most variations in firm level regressions the reverse size effect is statistically significant (or nearly) in the full period, even though it stems from the second subperiod only.

The results for the book-to-market variable are more stable across the two subperiods. For all variations of our test procedure, the coefficients on book-to-market are positive and mostly statistically significant. As a consequence of the stability of the book-to-market effect across both subperiods it is statistically significant for all variations of the test procedures in the full period. However, some patterns with respect to book-to-market emerge. (1) The coefficients on book-to-market and the t-values tend to be lower during the second period compared to the first period. (2) They also tend to be lower for monthly returns compared to quarterly returns. (3) Looking at value-weight returns yields slightly lower slopes on book-to-market and t-values compared to equal-weight returns. (4) The slopes on book-to-market are usually lowest when we use rolling post-ranking betas instead of full period or annual betas in monthly FM regressions. To elaborate the fourth point in more detail: In the full period the slope on book-to-market is approximately 30–45% lower. The corresponding t-values also decrease by approximately 30%. Monthly regression of value-weight portfolios sorted first on size and then on book-to-market (4x4) where we include monthly rolling betas as an independent variable yields quite favorable result for the CAPM. For these portfolios the t-values on book-to-market are below 1.64 in the first and second subperiod, for the full period the t-value is 1.99. The t-values for size are -1.71 in the first subperiod, 3.61 in the second and 1.14 in the full period. Slopes on beta are positive in the first subperiod (t-value is 1.73) and the overall period, but negative in the second subperiod, however, insignificant. We generally obtain the most unfavorable results for the CAPM when we look at results for firm level regressions.

Next we briefly look at the annualized intercepts from our cross-sectional FM regressions. In the first subperiod all intercepts are positive, most are statistically significant. The magnitude of the intercept is considerably high, on average 7.90% (EW) and 7.3% (VW). For the second subperiod the intercepts are all negative, on average -8.38% (EW) and -6.66% (VW). Most intercepts are, however, not statistically significant. In the full period most intercepts are positive on average 2.52% (EW) and 2.34% (VW), none are statistically significant. The t-values are close to zero, though.

We continue with the results for the BJS test (see Table 4 and 5). Using monthly return data we observe a strong book-to-market effect within the four portfolios in the top size ranking. The portfolio of the lowest book-to-market firms has a negative alpha, the portfolios with highest book-to-market have a positive alpha. This effect exists in both subperiods and as a consequence in the full period, it exists regardless of which ranking criterion is used first and of the weighting. This effect is persistent, but less pronounced in the group of portfolios with the second and third highest size ranking. This effect also shows up in the four book-to-market portfolios that contain the smallest firms, but only in the first subperiod. Among those portfolios the one with highest book-to-market has an alpha which is economically and statistically highly significant, regardless of the ranking criterion used first and of the weighting. In the second subperiod, all four book-to-market portfolios of small firms have negative or neutral alphas. The two portfolios of the firms with highest book-to-market have the most negative alphas. This "reverse book-to-market effect" among the smallest firms in the second subperiod shows up strongest when we look at value-weight portfolios sorted first on the book-to-market ratio (t=-3.22), but also in equal-weight portfolios. A regular book-to-market effect also exists in the full period for the smallest firms, but as a consequence of the reverse book-to-market effect in the second subperiod, it is less pronounced than for the three higher size groups.

The portfolio of small, high book-to-market firms has a positive and statistically significant alpha in the first subperiod, and a negative and usually significant alpha in the second subperiod. As a consequence, this portfolio has a near neutral risk-adjusted performance over all. Large, high book-to-market firms have a positive alpha in the first subperiod and perform economically and even statistically better in the second subperiod. As a consequence, their risk-adjusted return is significantly positive in the overall period. Large, low book-to-market firms have an extremely poor risk-adjusted return in the first subperiod, and in the second subperiod the alpha is just slightly negative. As a consequence, their risk-adjusted return is usually significantly negative in the overall period. Therefore, an important conclusion is the book-to-market effect in Germany varies over time within the different size classes, and for some portfolios considerably.

Loughran (1997) concludes that the book-to-market effect is "mostly a manifestation of the low returns on small newly-listed growth stocks outside of January coupled with a seasonal January effect for value firms." Furthermore Loughran (1997, p. 266-267) concludes that "[f]or the largest size quintile (accounting for, on average, 73% of all market value), book-to-market has no reliable predictive power for [U.S.] returns during the 1963-1995 period." Fama/French (2008) conclude for the period from 1963 to 2005, the book-to-market effect is consistent across different size groups. However, for the U.S. they also observe a stronger relation between average returns and book-to-market for microcaps and small stocks compared to large stocks. We observe for the period from 1960 to 1990 a strong book-to-market effect among small and large firms in both raw returns and risk-adjusted returns. However, for the second period the book-to-market effect tends to vanish or even reverse for small firms. The effect also tends to disappear for the firms from the large firm quartile when we first sort by size. The raw returns and alphas of these firms are virtually flat (close to zero), except for the highest book-to-market firms. The book-to-market effect is more pronounced during the second subperiod among large firms when we sort by book-to-market first.

Based on the analysis of Jensen's alphas we cannot clearly distinguish between the book-to-market effect and the reverse size effect in the second subperiod. As mentioned above, small firms' alphas are negative within the second subperiod across all book-to-market portfolios. This result may probably be attributed to the fact that small firms performed poorly from 1990 to 2007 irrespective of their book-to-market. Large firms performed very well from 1990 to 2007, especially those with higher book-to-market. Hence, the strong reverse size effect could superpose the book-to-market effect, especially for the smallest firms and possibly amplify the book-to-market effect for larger firms.

We close this section with a brief discussion of the results from the GRS test (see Panel B of Table 6). Looking at monthly returns for the full period we would reject the CAPM on a 5% significance level for 4x4 sorts. The p-values are sufficiently high in support of the CAPM when we look at quarterly data for value weight portfolios or annual return data. We generally estimate lower GRS p-values when we rank securities first by their book-to-market and then by size. The results are also stable with respect to the number of portfolios. However, the results for the GRS tests are dominated by the huge number of small stocks, which enter the GRS test with a weight of approximately 50-75% depending on the number of portfolios. Due to our concerns over stationarity of the portfolio betas we, therefore, look at p-values for non-overlapping 5-yr intervals which we average for the two subperiods and the overall period (see Panel B of Table 7). With one exception, all p-values are well above 0.10 for all variations in the test assets. We interpret these results in support of the CAPM. There are, however, 5-yr intervals where we obtain p-values below 0.10 for some variations in the test assets. For the period from 7/2000 to 6/2005 all p-values are below (or very close to) 0.01.

Based on the FM results reported in Table 10, where all three variables are included, and the BJS results in Table 4, we conclude that there is a moderate market-wide regular size effect from 1960 to 1990. This effect reverses in the period from 1990 to 2007, where we observe an economically and statistically significant reverse size effect. The book-to-market effect is more stable over time and mostly statistically significant in all three periods. Both effects are observed in FM regressions at the same time, this means that size does not dominate book-to-market or vice versa. Since we include beta as an independent variable, we have reason to assume that these effects prevail in risk adjusted returns. These results are in line with the GRS test results in Table 6.

6 Conclusion

Our empirical results are based on the well-known and still very popular test procedures of Black/Jensen/Scholes (1972), Fama/MacBeth (1973) and Gibbons/Ross/Shanken (1989). By applying these test procedures we find that empirical results vary considerable with the grouping procedure, weighting, and return interval. Our main concerns with respect to the test procedures are (1) sorts on size yield empirical results that are dominated by the plentiful but economically less important small and tiny German firms, and (2) portfolio betas are not stable over time. The main problem with small firms is that estimates of their systematic risk are downward biased due to non-trading, infrequent trading and serial correlated returns. Consistent with this argument, we find that results for longer return intervals and results for value-weight portfolios are more in line with the CAPM. In addition, our discussion of German peculiarities and our empirical results suggest that country specific peculiarities should be taken into account carefully. For Germany these include (1) choice of the considered market segments, (2) breakpoints to form portfolios, (3) tax refund in the amount of the corporate income tax, (4) dual class firms, and (5) the composition of the market portfolio.

With respect to the two anomalies, size and book-to-market, we find, in contradiction to the results of Artmann et al. (2012a, 2012b), important size and book-to-market effects in Germany. However, both effects are not stable over time. In the period from 1960 to 1990, we observe a regular size effect which reverses for the period from 1990 to 2007. This result is in line with international results and the results of Artmann et al. (2012a). The reverse size effect in the second subperiod is statistically significant in most variations of the test procedures. In both subperiods size plays an important role in explaining returns. However, the size-effect reverses around 1990 and, consequently, we find that size does not explain the cross-section of returns when we look at the full time period from 1960 to 2007. Our results for the second subperiod also cast some doubt on risk based explanations for the size effect. The slope on book-to-market has a positive sign in both subperiods, however, the effect is more pronounced in the first subperiod from 1960 to 1990. We also find that the book-to-market effect varies over time within the different size classes and for some portfolios considerably. In the second subperiod, for example, the book-to-market effect vanishes or even reverses for the firms from the smallest size quartile. Therefore, we do not recommend extending the CAPM by size and book-to-market characteristics in Germany.

We also hesitate to reject the CAPM, because the null of a zero slope on beta is not rejected. Grauer/Janmaat (2009) argue that such results might be caused by the low power of the FM test procedure, which is caused by the low inter portfolio spread in betas. With respect to the GRS test, we observe considerable variation in portfolio betas over time, even when we sort on pre-ranking betas. We also reject the null of normal i.i.d. residuals in our BJS regressions for most portfolios. As a consequence, the power of the GRS test is overstated and the GRS-p-values are too low. Results for the GRS tests are, thus, inconclusive when we look at longer time periods. We fix this problem by looking at GRS test statistics and p-values for 5-yr intervals as suggested by Gibbons/Ross/Shanken (1989). For most 5-yr intervals, the GRS test cannot reject the CAPM. Averages of the 5-yr GRS p-values for the two subperiods (1960-1990 and 1990-2007) and the full period (1960-2007) generally do not reject the CAPM. Overall, we conclude that the empirical evidence against the CAPM in

Germany, given the problems and open questions in the test procedures, is rather weak. Thus, our results and even more our interpretation of the results are in contrast to previous work for the German market by Artmann et al. (2012a, 2012b), who conclude that the CAPM fails to explain the cross-section of German stock returns.

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Appendix A: Description of the data set

A.1 Sample selection

Our initial data set includes all German firms where at least one class of shares was listed in the top segment of the Frankfurt stock exchange, the Amtlicher Markt, between December 1953 and October 2007.[85] We restrict our data set to this period for two reasons. First, book values of equity from 1948 to 1958 are currently not available to us. Second, we need a return series of 60 month to estimate pre-ranking firm betas to group securities beginning at the end of June in 1958. Third, the Amtlicher Markt was closed on October 31st, 2007. In order to avoid any selection bias, we include firms only for the period for which they were actually listed in the Amtlicher Markt in Frankfurt. IPOs and firms listed for the first time on an exchange are added to our data set at the end of the month of their first listing in the Amtlicher Markt. We assume that our data set includes all German firms for the entire time they are listed in the Amtlicher Markt in Frankfurt, and therefore, is free of a survivorship bias.[86]

We include the common and non-voting stocks of firms listed in the Amtlicher Markt in our data set. Following the argument of previous studies we omit financial firms. We exclude penny stocks, which we consider as stocks with share prices below €1 and an aggregated market value over all share classes of less than €5 mln.[87] We also remove profit participation bonds (Genussscheine) from our dataset, which are also not considered in our estimates of the book values of equity due to their debt character.

[85] Most studies for the German market as for example Oertmann (1994), Stehle (1997), Schlag/Wohlschließ (1997), Wallmeier (2000), Schulz/Stehle (2002) Artmann et al. (2012a, 2012b) also include only stocks listed in Frankfurt. However, this restriction is also a result of insufficient data availability and low data quality for other stock exchanges. In Section 2, we conclude that the Frankfurt stock exchange is representative for the German market.

[86] Some studies for the German market as for example Artmann et al. (2012a, 2012b) are not free of a survivorship bias

[87] Most penny stocks are stocks of bankrupt or nearly bankrupt firms that no longer publish financial statements.

Finally, we remove "Restquoten," bankrupt firms,[88] and firms that are liquidated, but still exchange listed, from our data set.[89]

A.2 Book value of equity

We collected book values of equity from the Handbücher der Deutschen Aktiengesellschaft (HBDA) for the period from 1957 to 1967. For the period from 1967 to 1990, we use the same book values of equity as Schrimpf et al. (2007). From 1990 we use the Worldscope Financial Database (Worldscope) as the primary source for the book values of equity.

The data set of Schrimpf et al. (2007) builds on data provided by the Deutsche Finanzdatenbank (DFDB), and covers the years from 1967 to 2002. The data set from HBDA and DFDB consist mainly of non-consolidated annual financial statements according to the German accounting standard HGB. Book values of equity are adjusted for non-equity components such as subscribed capital unpaid, treasury stocks and the equity portion of special untaxed reserves.[90] The book values from Worldscope consist mainly of consolidated financial statements based on HGB (before 2005) and IFRS (after 2005). In cases in which Worldscope did not report companies' book values of equities we either use the data of Schrimpf et al. (2007), HBDA, or the Hoppenstedt Aktienführer.

We switch from non-consolidated statements according to the German HGB to consolidated statements, because according to Gehrke (1994) few firms published consolidated annual financial statements including foreign subsidiaries before 1986.[91] In addition, the number of firms for which we have access to non-consolidated HGB statements decreases rapidly after 2002. Consolidated statements are only applied before December 1990 if non-consolidated statements are not available. We observe that the number of firms for which Worldscope reports consolidated statements according to IFRS rapidly increases after 2001, whereas the fraction of HGB statements steadily decreases.

A.3 Market value of equity (firm size)

We generally estimate the market value of equity (firm size) as the product of the stock price and the number of shares outstanding as of the end of each month. The number of shares was initially obtained by Stehle/Hartmond (1991) until the end of 1995 and by Schulz/Stehle (2002) for 1996 to 2002. We supplemented this data for the years 2003 to 2007 using Datastream (data type: NOSH). We carefully examined the quality of the data on the number of shares for the whole period using the Hoppenstedt

[88] E.g. the Bremer Bremer Vulkan Verbund AG filed for bankruptcy in May 1996, but remained its listing until June 2006.

[89] E.g. although, on May 26th, 1966 the share holders of Riebeck'sche Montanwerke AG decided to liquidate the company, its shares were listed in the Amtlicher Markt until September 9th, 1982 and in the Freiverkehr (the lowest market segment) in Frankfurt until 2002. For the same reason we removed Mauser Waldeck AG (liquidated since October 22nd, 2002) and I.G. Farbenindustrie AG (liquidated since February 1st, 1952) from our data set.

[90] See Schulz/Stehle (2002) and Stehle (1994) for more details on the estimation of the book value of equity.

[91] According to Küting/Weber (1987) the Bilanzrichtlinien-Gesetz (BiRiLiG) from December 19th, 1985 implemented the 7th EG-Richtlinie, which specified that firms have to include foreign subsidiaries in their consolidated statements for financial years starting on December 31st , 1989.

Aktienführer, Saling Aktienführer and HBDA (fact books). In addition, we cross-checked the number of shares using our data on stock splits, stock dividends, right issues, and reverse stock splits.

We identified 38 stocks for which the number of shares outstanding differs significantly from the number of listed shares. The most prominent example of such a firm is the Deutsche Telekom AG, which issued approximately 2.993 billion shares of which only 1 billion were listed from November 1996 to May 1999. We believe that adjusting the market value of equity for unlisted shares improves our firm size estimate.

Firm size is measured by the market value of the total equity of a firm. A firm's equity portfolio value is typically calculated on the basis of the common and preferred stock prices and the number of shares issued in both classes.[92] However, we identified 42 firms that had for some time period only their preferred stocks listed in the Amtlicher Markt, but not their common stocks. If only one type of stocks is exchange listed, we use its price to estimate the market value of the unlisted type.[93] We also identified 3 cases where only the common stocks but not the preferred stocks were listed.

We calculate the book-to-market ratio using the aforementioned aggregated market capitalization over all listed and unlisted share classes. We apply the same market value of equity as a proxy for firm size. However, we take the market value of listed shares only (the aggregate over all share classes) when we calculate market-value weighted rates of return of portfolios. We use the natural logarithm of firm size and the B/M-ratio as independent variables in our cross-sectional regressions.

A.4 Rates of return calculation

The data required to calculate stocks' monthly rates of return is obtained from a database for the Amtlicher Markt, which covers the period from 1953 to October 2007. The original database by Stehle/Hartmond (1991) was supplemented by Schulz/Stehle (2002) and Brückner/Stehle (2012) until October 2007.[94] The data was primarily obtained from the Hoppenstedt Kurstabellen, the above mentioned fact books, the Karlsruher capital market database (KMDB),[95] Thomson Datastream, and the Börsenzeitung. The database generally contains the following data types: i) the last price of each month, ii) the number of shares outstanding, iii) dividends and information on pure stock splits, iv) stock dividends, v) right issues, vi) reverse stock splits, and vii) other financial benefits. The rates of return of firms that have multiple share classes outstanding are estimated as the value-weighted rate of return over all listed share classes in the Amtlicher Markt.

We calculate monthly rates of return from the perspective of small domestic investors. This means that

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92 We adjust firm size for the market value of share classes that were not listed in the Amtlicher Markt in Frankfurt, but in other market segments or stock exchanges. E.g.: Glunz AG and König&Bauer AG.

93 Daske/Erhardt (2002) show that the prices of common stocks are on average 19.18% higher than those of non-voting stocks (1956 to 1998). However, this difference is not stable over time, hence we do not adjust prices of common stocks.

94 The data set was applied among others by Schrimpf et al. (2007), Ziegler et al. (2007), Brückner/Stehle (2012), and Pryshchepa/Stehle (2011).

95 The KKMDB is described by Bühler et al. (1993) and Herrmann (1996).

we adjust the monthly rates of return for share reallocations from majority to minority share holders,[96] dividends which are only distributed to minority or free share holders[97] and corporate income tax credits (Körperschaftsteuergutschrift). For firms with multiple share classes we aggregate the rates of return by the exchange listed market capitalization of each share class. This means that we are creating artificial assets, which are considered in our empirical tests.

A.5 Estimating portfolio characteristics

We generally form our characteristic portfolios as of the end of June of year t. Portfolios' equal-weighted and value-weighted monthly, quarterly and annual returns are estimated for the period from July in year t to June in year t+1, from t = 1958 to 2007. Based on these portfolio returns we estimate portfolios' post-ranking full-period and rolling betas, regressing the returns of the portfolio on our value-weighted proxy for the market portfolio. Dimson betas include the one-period lagged market return. Rolling betas are estimated based on a 24 to 60 month period (as available).

Portfolio size $Size_{P,t}$ and book-to-market $BM_{P,t}$ are estimated following Kothari et al. (1995) as:

$$Size_{P,t} = \ln\left(\sum_{i=1}^{N_{P,t}} w_{i,t} * Size_{i,t}\right), \text{ and } BM_{P,t} = \ln\left(\sum_{i=1}^{N_{P,t}} w_{i,t} * BM_{i,t}\right) \tag{4}$$

where $N_{P,t}$ is the number of firms in portfolio P as of June in year t, $w_{i,t}$ is the weight of firm i as of June in year t in portfolio P, $Size_{i,t}$ is the market value of equity of firm i as of June in year t, and $BM_{i,t}$ is book-to-market of firm i as of June in year t (estimated as of December in year t-1). We estimate $w_{i,t} = N_{P,t}^{-1}$ for equal-weight and as $w_{i,t} = Size_{i,t} \Big/ \sum_{j=1}^{N_{P,t}} Size_{j,t}$ for value-weight portfolios.

It would also be reasonable to estimate portfolios' size and book-to-market averaging the natural logarithms of firms' characteristics. Hence we could alternatively use:

$$Size_{P,t} = \sum_{i=1}^{N_{P,t}} w_{i,t} * \ln\left(Size_{i,t}\right) \text{ and } BM_{P,t} = \sum_{i=1}^{N_{P,t}} w_{i,t} * \ln\left(BM_{i,t}\right) \tag{5}$$

We decided to estimate portfolios size and book-to-market characteristics according to Equation (4), since we believe that it is more in line with the literature. However, the difference between both measures (Equation 4 vs. 5) depends on the intra-portfolio spread in firms' size. Hence, we assume that this issue is relevant only in cross-sectional regressions that include portfolio size as an independent variable when portfolios are not formed on size. For size sorted portfolios, the difference should be negligible.

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[96] E.g. in November 1993 FAG Kugelfischer AG, the majority share holder of Dürkopp Adler AG, distributed one for ten shares of Dürkopp Adler AG to all minority share holders of that company.

[97] E. g. Audi AG and MAN Roland Druckmaschinen AG.

Appendix B: Figures and Tables

All our portfolios (test assets) and therefore all our results presented in the tables in this appendix are based on exactly the same data set. Our grouping procedures only consider firms with positive book-to-market and a return time series of at least 24 month as of the end of June in year t. Financial firms and penny stocks are not considered by the grouping procedure.

In addition, we generally exclude the smallest 10% of the firms in our sample. Therefore, we do not include the firms that have been assigned to size decile D01 (smallest firms in Panel A of Table 3), (1) when we form 16 and 20 size portfolios, (2) when we sort by criterions other then size, and (3) when we form two-dimensional groups. We also do not include the portfolio of the smallest firms in our FM regressions based on portfolio data. The results are, however, robust to whether or not we remove size decile D01.

Size is measured by a firms' aggregate market value of equity over all share classes as of the end of June in year t, also taking unlisted shares into account. Book-to-market is measured as of the end of December in year t-1. Firms' pre-ranking Dimson Betas are estimated at the end of June in year t using a time series of 24 to 60 months (as available). We use these firm characteristics to form our portfolios. Each portfolio represents approximately 1/k percent of the firms, where k denotes the number of groups. The portfolios representing the firms with the smallest characteristic usually include slightly more than 1/k percent of the firms. This is due to the fact that we assign left over firms to these portfolios. For these portfolios we calculate monthly, quarterly, and annual rates of returns from July in year t to June in year t+1.

We present portfolio characteristics and regression results for the overall period from July 1960 to October 2007 as well as two subperiods. The first subperiod extends from July 1960 to June 1990, the second from July 1990 to June 2007. We also present results for equal-weight as well as value-weight portfolios.

Figure 1: Variation in U.S. and German 5-yr rolling Dimson (1 lag) beta estimates for value-weight size portfolios over time, 7/1960- 10/2007.

The upper graph shows rolling Dimson beta estimates for the U.S.; the bottom graph shows rolling Dimson betas for the German market. The return data for the U.S. size portfolios is from French's data library. The U.S. market portfolio is proxied by the S&P 500. For Germany we sort all firms (except financial firms) with a return record of at least 24 month and positive book-value of equity at the end of the fiscal year t-1 into one of ten size-portfolios as at the end of June in year t. The German market portfolio is proxied by a portfolio of all stocks from the highest segment of the Frankfurt stock exchange (Amtlicher Markt). For Germany we additionally form a portfolio of all financial firms listed in this segment. We estimate 5-yr rolling (using a min. of 24 returns, as available) Dimson betas (1 lag) for these portfolios starting in July 1960 to October 2007.

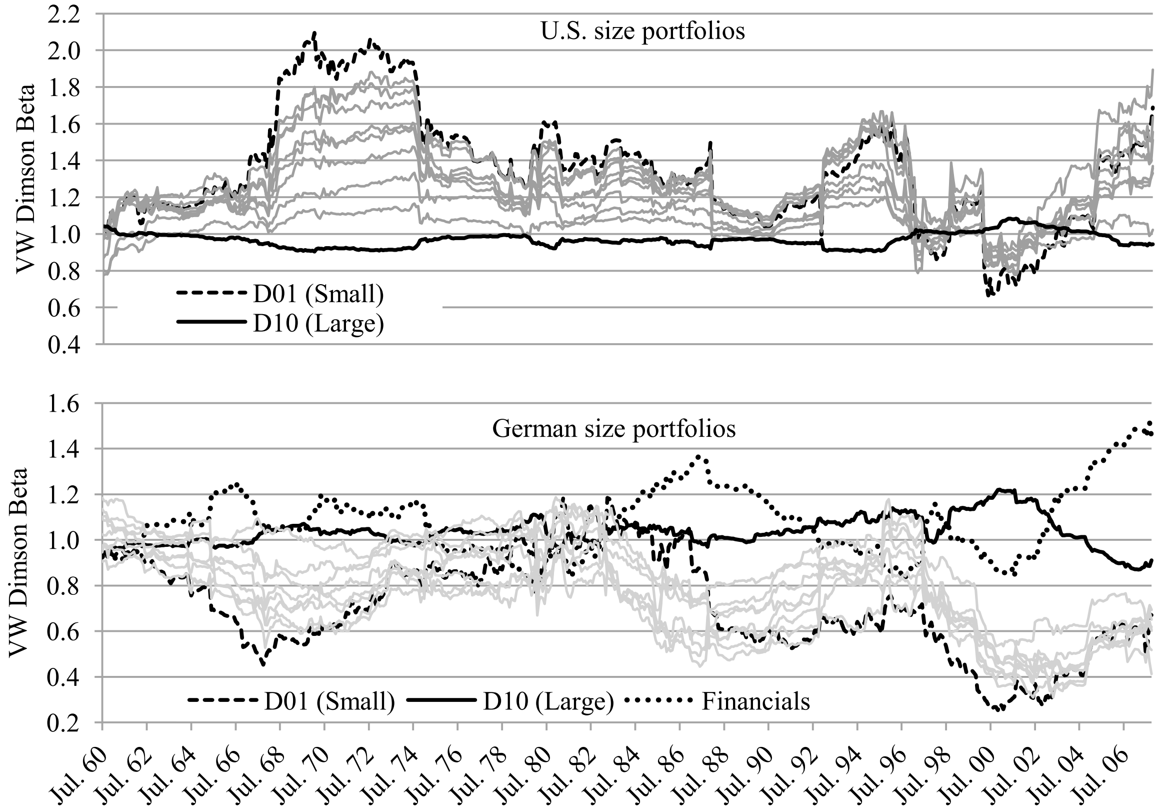
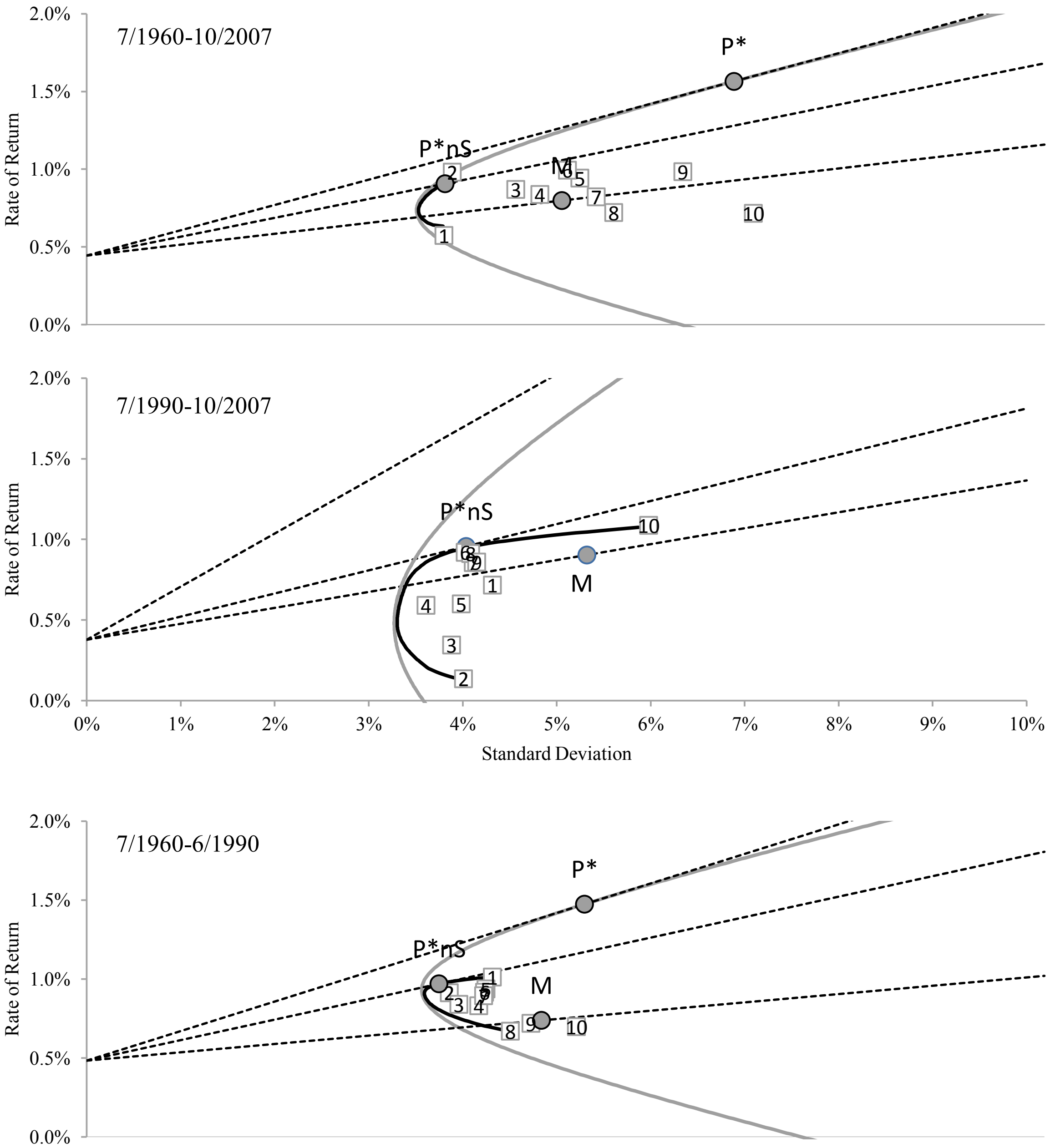


Figure 2: Mean-variance frontiers of value-weight size decile portfolios and the market portfolio.

Panel A shows the location of the N test assets (value-weight size decile portfolios), the market portfolio, M, and the tangency portfolios, P* and P*ns in risk-return space for the full period, 7/1960–10/2007 and the two subperiods, 7/1960–6/1990 and 7/1990–10/2007. *P** is the unconstrained tangency portfolio of the *N*+1 assets (including *M*). *P*ns* denotes the case where short sales are not allowed. The dashed lines display the characteristic lines of the specified portfolios. In Panel B we provide characteristics of *P** and *P*ns*, namely the implied weights of the *N*+1 test assets, their mean return (mu) and standard deviation (sd) as well as the Sharpe ratio (SR) and the results of the GRS test.

Panel A:



Panel B:

Period	Portf.	Implicit weights of the test assets and market portfolio (in %)											in %			GRS	
		1	2	3	4	5	6	7	8	9	10	M	mu	sd	SR	F	p
60-07	P*	88	-95	-69	-29	41	165	130	-75	-38	121	-140	1.56	6.8	17	1.24	0.26
	P*nS	39	0	0	0	0	46	14	0	0	0	0	0.91	3.7	12	0.56	0.84
60-90	P*	42	57	-7	-28	100	79	62	-143	-70	-12	18	1.47	5.2	19	1.16	0.31
	P*nS	51	24	0	0	25	0	0	0	0	0	0	0.97	3.7	13	0.51	0.88
90-07	P*	151	-799	-681	5	-173	608	362	485	241	459	-557	11.78	34.6	33	1.93	0.04
	P*nS	0	0	0	0	0	51	0	26	0	23	0	0.96	4.0	14	0.21	1.00

Figure 3: Rolling 5-yr Dimson beta estimates for equal-weight and (market) value-weight portfolios sorted on firm size, 7/1960-10/2007.

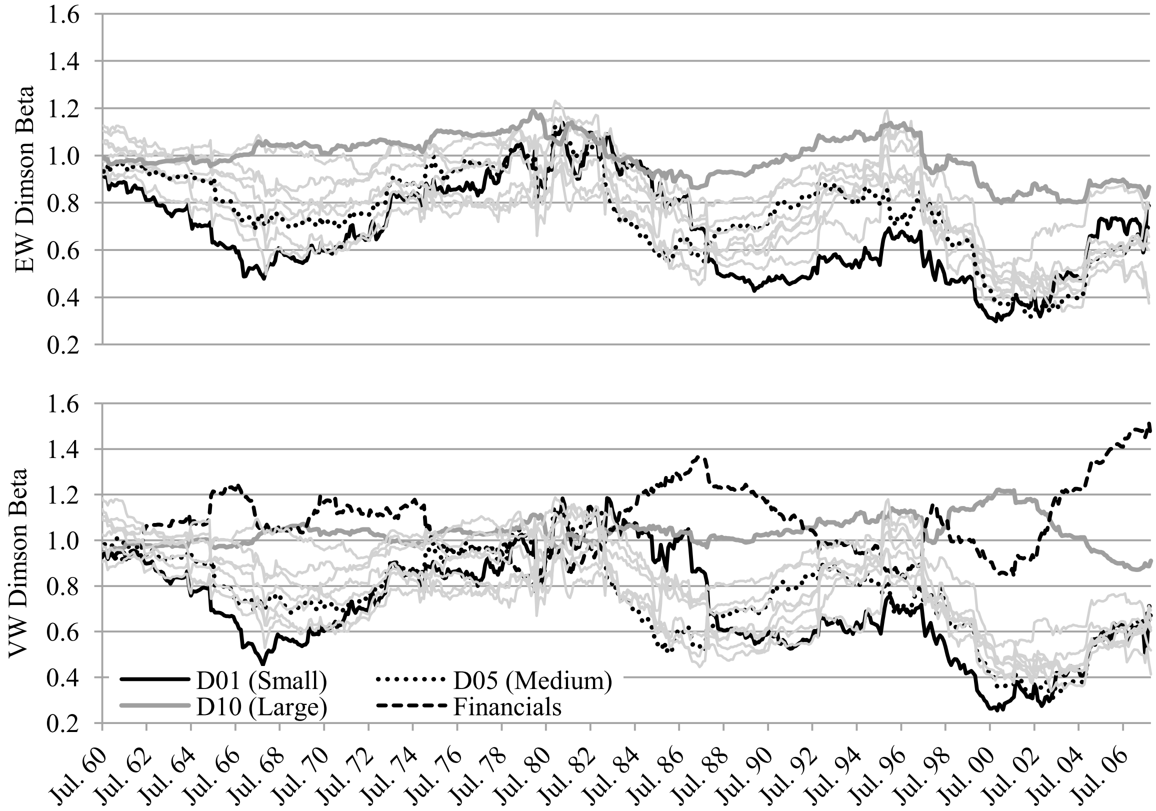


Figure 4: Rolling 5-yr Dimson beta estimates for equal-weight and (market) value-weight portfolios sorted on book-to-market, 7/1960-10/2007.

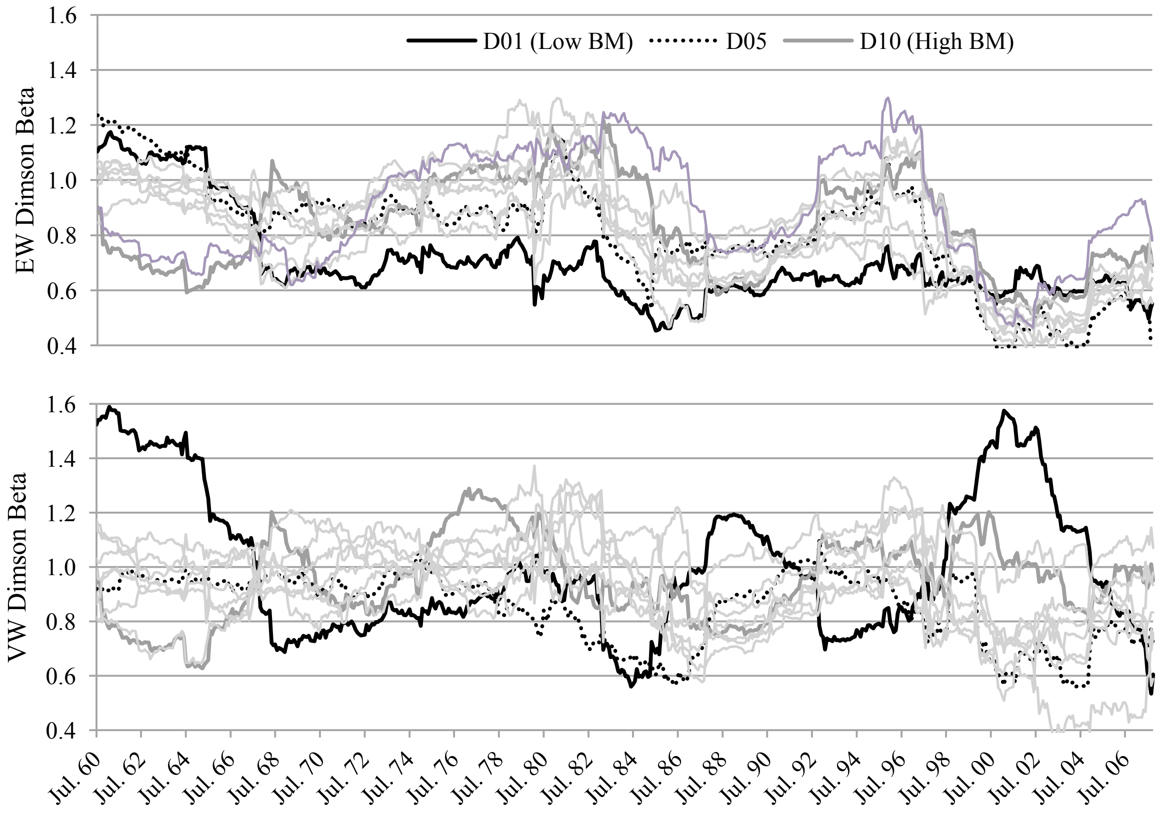


Figure 5: Rolling 5-yr Dimson beta estimates for equal-weight and (market) value-weight portfolios sorted on Dimson beta, 7/1960-10/2007.

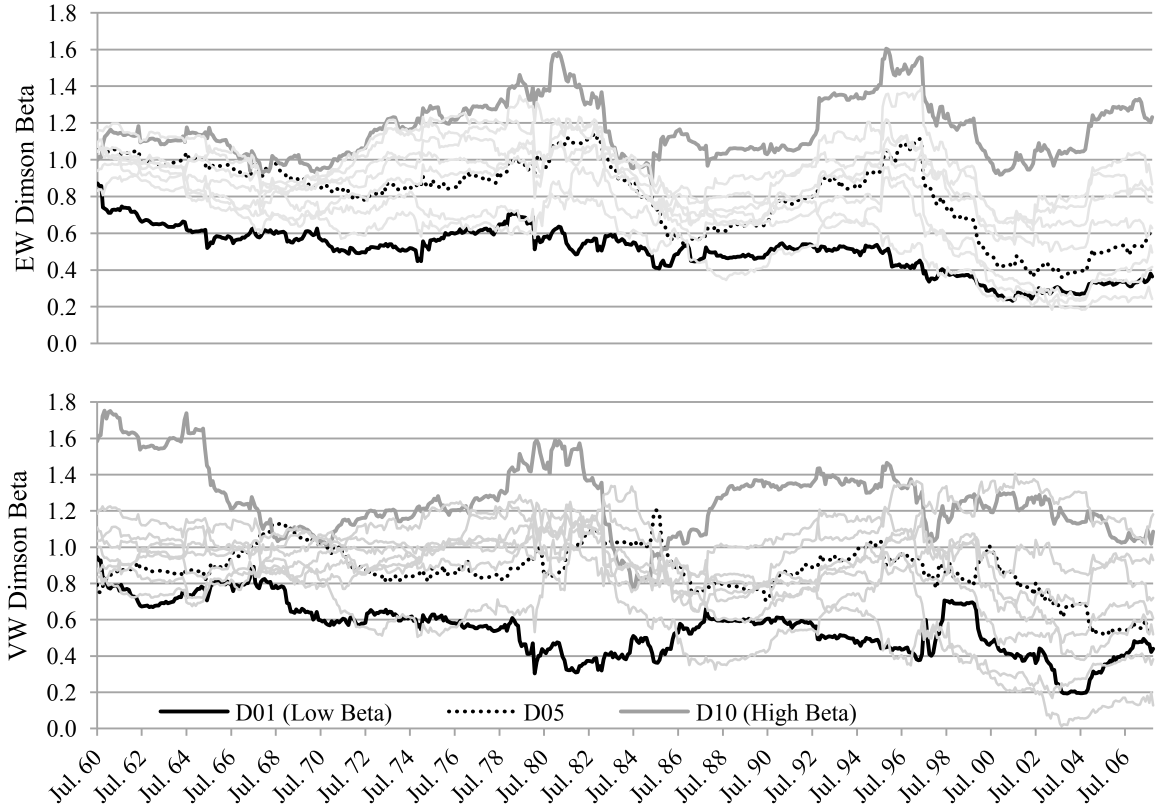


Figure 6: Number of German firms with pre-ranking betas above and below unity, 7/1960-10/2007.

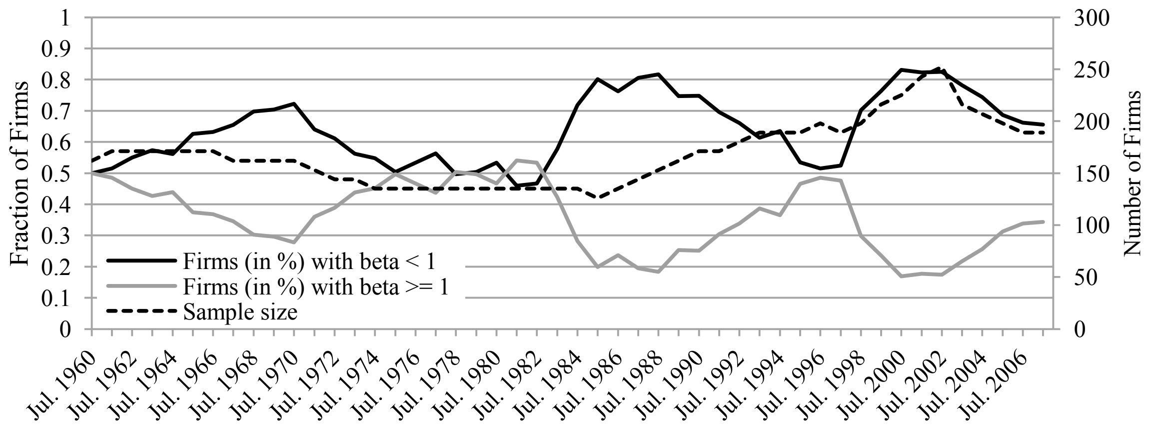


Figure 7: Rolling 5-yr Dimson beta estimates (market) value-weight portfolios sorted first on firm size and then on book-to-market, 7/1960-10/2007.

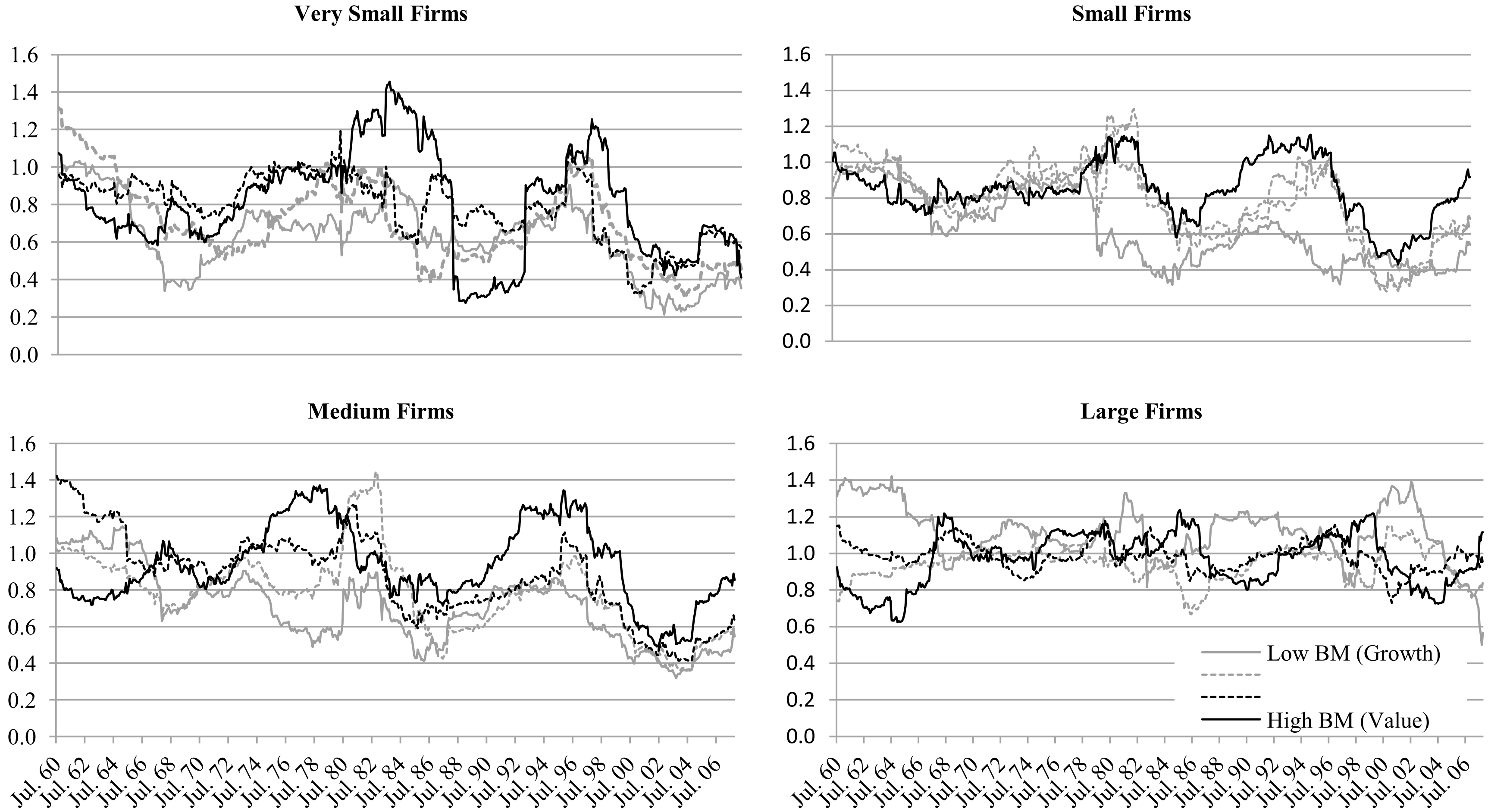


Table 1: Summary statistics for size deciles, 7/1960 to 10/2007.

The table reports the average number of firms, market capitalization (size), number of IPOs, dividend yield, and number of dividend paying firms for ten portfolios sorted by firm size. At the end of June of each year we assign all non-financial firms that are listed in the Amtlicher Markt in Frankfurt, and fulfill our data requirements (pos. book-to-market, return record of at least 24 month to estimate a Dimson beta) to one of ten portfolios based on firm size (aggregated market capitalization over all outstanding share classes). The average firm size is approximated by the arithmetic mean over all firms of a portfolio. IPOs are assigned to their hypothetical size-portfolio by comparing their size at the end of the IPO month to the portfolios' size borders as of the end of the preceding June. We calculate a firm's dividend yield as of June in year t by dividing dividends (adjusted for stock dividends and stock splits) from July in year t-1 to June in year t with stock price as of the end of June in year t. The average dividend yield of a portfolio is estimated as the arithmetic mean over all firms in the portfolio (including firms that pay no dividends). We also present the average fraction of dividend paying firms.

Period	D01 (Small)	D02	D03	D04	D05	D06	D07	D08	D09	D10 (Large)
Average Number of Firms										
1960-2007	24	19	19	19	19	19	19	19	19	19
1960-1969	25	19	19	19	19	19	19	19	19	19
1970-1979	20	16	16	16	16	16	16	16	16	16
1980-1989	21	16	16	16	16	16	16	16	16	16
1990-1999	25	21	21	21	21	21	21	21	21	21
2000-2007	27	24	24	24	24	24	24	24	24	24
Average Real Market Capitalization (in Mio. € , in Prices of 2007)										
1960-2007	19	45	79	133	209	324	515	871	1932	9981
in %	0.14	0.32	0.56	0.95	1.48	2.29	3.65	6.17	13.69	70.74
1960-1969	10	25	44	77	133	203	289	462	872	3991
1970-1979	12	31	57	105	159	233	346	543	961	3667
1980-1989	19	46	83	138	217	333	529	759	1407	6070
1990-1999	38	80	134	211	308	457	721	1182	2576	12813
2000-2007	19	44	80	137	235	408	734	1541	4320	26711
IPO Distribution (220 Observations)										
1960-2007	12	22	29	32	33	21	24	18	19	10
in %	5.45	10.00	13.18	14.55	15.00	9.55	10.91	8.18	8.64	4.55
1960-1969	0	0	1	0	0	0	0	0	0	1
1970-1979	1	3	1	1	4	2	1	1	3	5
1980-1989	2	4	9	11	14	9	6	6	5	1
1990-1999	9	15	14	13	10	5	14	6	10	3
2000-2007	0	0	4	9	8	7	6	7	2	0
Average Dividend Yield (in %)										
1960-2007	2.03	2.97	2.82	3.00	2.96	2.96	2.79	2.98	2.84	3.14
1960-1969	2.87	4.40	3.78	3.43	3.39	3.01	3.42	3.08	3.78	3.57
1970-1979	1.77	2.68	2.89	3.08	3.45	3.37	3.10	3.60	3.71	4.22
1980-1989	1.92	2.21	2.66	2.49	2.61	2.57	2.31	2.52	2.54	3.19
1989-1999	2.09	2.70	2.45	2.47	2.49	2.13	2.08	2.24	1.80	2.32
2000-2007	1.36	2.80	2.16	3.64	2.85	3.89	3.12	3.60	2.25	2.23
Average Fraction of Dividend Paying Firms (in %)										
1960-2007	56.0	71.8	76.7	78.1	80.6	82.4	82.6	85.3	88.4	93.2
1960-1969	68.7	88.8	86.6	82.7	81.8	84.9	87.7	88.7	91.3	94.1
1970-1979	53.3	77.3	84.8	84.8	85.6	82.7	85.0	83.7	86.5	90.1
1980-1989	60.7	77.1	79.1	77.8	84.0	84.3	79.8	84.8	87.0	90.0
1989-1999	66.0	66.2	73.5	78.2	81.7	83.6	75.5	84.3	90.4	96.7
2000-2007	25.1	44.4	55.1	64.3	67.4	75.0	85.9	85.2	86.3	95.4

Table 2: Portfolio assignments, OLS vs. Dimson beta, 7/1960 – 10/2007.

In June of each year from 1960 to 2007 we separately group firms by their pre-ranking OLS and Dimson beta (1 lag) into decile portfolios. Decile D01 represents the firms with the smallest beta, D10 those with the highest beta. Firms‘ betas are estimated by the two methods using 24 to 60 observations (as available). Firms on the diagonal line were assigned to the same decile portfolio under both beta estimation methods. For Dimson beta sorted portfolios we present time series averages (arithmetic means) of firms' individual Dimson (Avg. Dimson) and OLS (Avg. OLS) beta estimates. For Dimson beta sorted portfolios we estimate equal-weighted (EW) and value-weighted (VW) monthly returns. Based on these returns we estimate portfolios' monthly full period betas (Dimson and OLS). EW Lag and VW Lag are the average slopes on the lagged market excess return for these portfolios. EW SE and VW SE are the standard errors of the OLS slopes on the market excess return for Dimson beta sorted portfolios.

		Low				Dimson Beta Sorts					High
		D01	D02	D03	D04	D05	D06	D07	D08	D09	D10
OLS Beta Sorts, Low	D01	70.3	18.7	4.6	3.0	1.2	0.5	1.0	0.1	0.6	0.0
	D02	22.1	36.7	24.6	10.4	3.4	1.8	0.7	0.2	0.0	0.0
	D03	10.8	22.2	28.9	15.8	12.6	4.5	2.4	1.5	1.2	0.1
	D04	2.3	9.5	20.0	25.1	18.3	12.5	6.6	4.3	0.9	0.5
	D05	1.5	4.8	11.7	20.0	19.8	18.8	13.0	6.5	2.6	1.3
	D06	0.4	1.7	4.4	13.3	20.7	22.2	17.1	11.7	6.5	2.0
	D07	0.2	1.2	3.1	7.6	13.4	18.9	23.5	19.1	7.9	5.0
	D08	0.2	0.1	1.1	3.2	7.5	13.7	21.9	23.2	21.0	8.1
	D09	0.0	0.0	0.4	0.9	2.4	5.7	11.5	26.3	31.8	21.0
High	D10	0.0	0.0	0.0	0.0	0.4	1.1	2.1	7.1	27.4	62.0
Avg. Dimson		0.16	0.43	0.57	0.69	0.79	0.89	0.99	1.11	1.27	1.64
Avg. OLS		0.19	0.39	0.51	0.63	0.71	0.80	0.87	0.97	1.10	1.33
Difference		-0.03	0.03	0.06	0.06	0.07	0.09	0.11	0.13	0.17	0.31
EW Lag		0.10	0.09	0.10	0.08	0.07	0.08	0.09	0.08	0.08	0.09
(t-Value)		(7.53)	(4.71)	(4.65)	(4.28)	(3.41)	(3.92)	(4.00)	(3.93)	(3.37)	(3.07)
VW Lag		0.10	0.06	0.02	0.03	-0.03	-0.03	0.00	0.00	0.01	0.00
(t-Value)		(3.78)	(2.44)	(0.73)	(1.07)	(-1.21)	(-1.19)	(0.07)	(0.10)	(0.20)	(0.08)
EW SE		0.0183	0.0199	0.0213	0.0211	0.0211	0.0208	0.0218	0.0219	0.0228	0.0279
VW SE		0.0255	0.0252	0.0274	0.0238	0.0244	0.0232	0.0241	0.0230	0.0242	0.0278

Table 3: Descriptive statistics and empirical results for one-dimensional sorts (decile portfolios) on size, book-to-market and Dimson beta, 07/1960-06/1990, 07/1990-10/2007, and 07/1960-10/2007.

The following three panels, A, B, and C of this table present descriptive statistics for one-dimensional sorted decile portfolios. Portfolios are formed by sorts on size (panel A), book-to-market (panel B), and Dimson beta (panel C). Portfolios' average monthly excess rate of return is estimated as the arithmetic mean of the portfolios' return less the risk-free rate (SU0104). We estimate the monthly standard deviations of the rates of return from annual rates of return. Pre-ranking Dimson betas are the averages of a portfolio's firms pre-ranking Dimson betas as of the end of June in year t. Post-ranking Dimson betas are estimated using the full return time series for the stated period. Jensen's alphas are the intercepts from equation (1) in section 4.1; a time series regression á la BJS extended by the lagged market excess rate of return to adjust for the infrequent trading bias. The differences between the results from the standard and the extended BJS model are marginal. We annualize monthly alphas multiplying them with 12. The t-values for the alphas are *Newey/West* (1994) adjusted. We also present GRS test statistics and the associated p-values based on monthly return intervals. The bottom rows present the average, inflation adjusted size of a portfolio.

Table 3, Panel A: Descriptive statistics, BJS and GRS results for size sorted decile portfolios.

	Equal-weight portfolios formed on firm size										Value-weight portfolios formed on firm size									
	D01 (Small)	D02	D03	D04	D05	D06	D07	D08	D09	D10 (Large)	D01 (Small)	D02	D03	D04	D05	D06	D07	D08	D09	D10 (Large)
	7/1960-10/2007										7/1960-10/2007									
Monthly excess return (in %)	0.59	0.19	0.17	0.30	0.39	0.43	0.45	0.31	0.35	0.37	0.46	0.18	0.21	0.30	0.37	0.47	0.44	0.31	0.33	0.40
Std. (in %, from annual returns)	6.57	5.17	4.83	5.28	5.62	5.71	5.20	4.91	5.67	5.78	5.73	5.23	4.98	5.38	5.40	5.94	5.25	5.05	5.75	6.36
Pre-ranking Dimson beta	0.69	0.77	0.74	0.75	0.80	0.79	0.85	0.87	0.91	0.98	0.70	0.77	0.74	0.75	0.80	0.79	0.85	0.88	0.91	1.03
Post ranking Dimson beta	0.62	0.65	0.68	0.69	0.71	0.74	0.76	0.80	0.86	0.97	0.64	0.66	0.66	0.67	0.71	0.73	0.75	0.80	0.84	1.04
Jensen's alpha (1 lag, annualized)	4.44	-0.47	-0.88	0.64	1.60	1.95	2.13	0.27	0.51	0.39	2.73	-0.64	-0.27	0.70	1.38	2.56	2.04	0.34	0.34	0.37
Adj. t-value	(1.81)	(-0.29)	(-0.59)	(0.42)	(1.04)	(1.25)	(1.64)	(0.21)	(0.50)	(0.49)	(1.33)	(-0.40)	(-0.17)	(0.44)	(0.92)	(1.54)	(1.54)	(0.25)	(0.33)	(0.51)
GRS-test (p-value)	1.63	(0.09)									1.16	(0.31)								
	7/1960-6/1990										7/1960-6/1990									
Monthly excess return (in %)	0.58	0.41	0.33	0.40	0.47	0.43	0.45	0.18	0.24	0.14	0.53	0.43	0.36	0.35	0.45	0.43	0.41	0.19	0.24	0.22
Std. (in %, from annual returns)	5.68	4.77	4.75	5.50	5.28	6.00	5.19	4.96	6.20	5.71	5.49	4.87	4.86	5.37	5.30	6.42	5.14	4.96	6.26	6.31
Pre-ranking Dimson beta	0.72	0.80	0.79	0.80	0.87	0.83	0.87	0.94	0.98	1.02	0.75	0.81	0.79	0.80	0.87	0.83	0.87	0.94	0.98	1.03
Post ranking Dimson beta	0.66	0.68	0.74	0.76	0.79	0.80	0.81	0.88	0.93	1.00	0.73	0.69	0.72	0.74	0.79	0.79	0.80	0.88	0.93	1.02
Jensen's alpha (1 lag, annualized)	4.80	2.79	1.65	2.42	3.18	2.68	2.94	-0.53	0.08	-1.39	4.03	2.99	2.03	1.87	3.00	2.76	2.47	-0.48	-0.01	-0.53
Adj. t-value	(1.94)	(1.61)	(0.98)	(1.44)	(2.21)	(1.69)	(2.17)	(-0.44)	(0.08)	(-2.02)	(1.73)	(1.68)	(1.13)	(1.12)	(2.05)	(1.69)	(1.87)	(-0.38)	(-0.01)	(-0.78)
GRS-test (p-value)	1.65	(0.09)									1.06	(0.39)								
	7/1990-10/2007										7/1990-10/2007									
Monthly excess return (in %)	0.62	-0.18	-0.11	0.13	0.25	0.43	0.44	0.52	0.52	0.79	0.34	-0.24	-0.03	0.21	0.22	0.54	0.48	0.53	0.48	0.71
Std. (in %, from annual returns)	8.09	5.63	4.87	4.92	6.31	5.32	5.38	4.88	4.76	5.88	6.28	5.57	5.16	5.54	5.67	5.19	5.60	5.28	4.90	6.55
Pre-ranking Dimson beta	0.63	0.71	0.66	0.67	0.69	0.73	0.82	0.77	0.80	0.93	0.64	0.72	0.66	0.68	0.68	0.73	0.81	0.77	0.81	1.02
Post ranking Dimson beta	0.56	0.60	0.59	0.60	0.61	0.67	0.69	0.67	0.75	0.92	0.53	0.62	0.58	0.58	0.60	0.65	0.67	0.69	0.72	1.05
Jensen's alpha (1 lag, annualized)	3.96	-6.03	-5.07	-2.22	-0.87	0.89	0.92	1.99	1.55	3.62	0.75	-6.83	-4.07	-1.08	-1.14	2.44	1.51	2.08	1.27	1.87
Adj. t-value	(0.95)	(-2.07)	(-1.86)	(-0.80)	(-0.28)	(0.31)	(0.33)	(0.78)	(0.77)	(2.41)	(0.20)	(-2.51)	(-1.49)	(-0.36)	(-0.37)	(0.76)	(0.54)	(0.78)	(0.65)	(1.31)
GRS-test (p-value)	2.36	(0.01)									2.06	(0.03)								
	Average real market capitalization (in mln. €, in prices of 2007)										Average real market capitalization (in mln. €, in prices of 2007)									
1960-2007	19	45	79	133	209	324	515	871	1932	9981	23	47	82	136	213	330	526	902	2070	16726
in %	0.14	0.32	0.56	0.95	1.48	2.29	3.65	6.17	13.69	70.74	0.11	0.22	0.39	0.65	1.01	1.57	2.50	4.28	9.83	79.44
1960-1990	13	34	61	107	170	257	388	588	1080	4576	16	35	63	109	173	261	393	600	1125	6704
1990-2007	30	64	110	178	276	435	727	1342	3351	18990	34	66	113	181	281	446	747	1405	3646	33430

Table 3, Panel B: Descriptive statistics, BJS and GRS results for book-to-market sorted decile portfolios.

Equal-weight portfolios formed on B/M

	D01 (Low)	D02	D03	D04	D05	D06	D07	D08	D09	D10 (High)
7/1960-10/2007										
Monthly excess return (in %)	0.03	0.28	0.20	0.28	0.29	0.35	0.33	0.48	0.44	0.69
Std. (in %, from annual returns)	4.17	5.05	4.65	5.29	5.23	4.92	5.03	6.19	6.23	6.66
Pre-ranking Dimson beta	0.73	0.76	0.81	0.85	0.82	0.90	0.91	0.90	0.86	0.81
Post-ranking Dimson beta	0.69	0.74	0.71	0.78	0.75	0.77	0.78	0.81	0.83	0.76
Jensen's Alpha (1 lag, annualized)	-2.57	0.15	-0.60	-0.01	0.30	0.94	0.64	2.34	1.71	5.03
Adj. t-Value	(-2.07)	(0.11)	(-0.51)	(-0.01)	(0.23)	(0.84)	(0.43)	(1.38)	(0.98)	(2.65)
GRS-Test (p-Value)	1.90	0.04								
7/1960-6/1990										
Monthly excess return (in %)	0.07	0.27	0.19	0.18	0.33	0.31	0.35	0.40	0.53	0.87
Std. (in %, from annual returns)	4.38	5.29	4.76	5.36	5.56	5.10	5.09	5.63	6.18	6.76
Pre-ranking Dimson beta	0.74	0.82	0.86	0.90	0.91	0.95	0.99	0.95	0.88	0.84
Post-ranking Dimson beta	0.72	0.81	0.76	0.86	0.84	0.86	0.86	0.89	0.86	0.78
Jensen's Alpha (1 lag, annualized)	-1.41	0.68	-0.05	-0.52	1.39	1.11	1.52	2.01	3.67	7.95
Adj. t-Value	(-0.91)	(0.44)	(-0.04)	(-0.41)	(1.06)	(1.01)	(1.10)	(1.46)	(2.17)	(3.82)
GRS-Test (p-Value)	2.17	0.02								
7/1990-10/2007										
Monthly excess return (in %)	-0.03	0.29	0.22	0.45	0.22	0.42	0.31	0.64	0.29	0.39
Std. (in %, from annual returns)	3.87	4.75	4.59	5.28	4.72	4.76	5.05	7.21	6.43	6.46
Pre-ranking Dimson beta	0.71	0.65	0.73	0.76	0.68	0.83	0.78	0.83	0.82	0.76
Post-ranking Dimson beta	0.65	0.64	0.64	0.66	0.63	0.64	0.68	0.71	0.81	0.75
Jensen's Alpha (1 lag, annualized)	-4.46	-0.51	-1.37	1.18	-1.28	0.99	-0.61	3.20	-1.61	0.01
Adj. t-Value	(-2.40)	(-0.24)	(-0.64)	(0.45)	(-0.47)	(0.43)	(-0.21)	(0.83)	(-0.48)	(0.00)
GRS-Test (p-Value)	0.99	0.45								
Average real market capitalization (in mln. €, in prices of 2007)										
1960-2007	1827	1684	1569	2072	1749	1556	1609	1574	1089	872
in %	11.71	10.79	10.06	13.28	11.21	9.97	10.32	10.09	6.98	5.59
1960-1990	794	722	795	817	870	926	905	962	761	520
1990-2007	3550	3286	2860	4164	3215	2607	2784	2594	1636	1459

Value-weight portfolios formed on B/M

	D01 (Low)	D02	D03	D04	D05	D06	D07	D08	D09	D10 (High)
7/1960-10/2007										
Monthly excess return (in %)	0.04	0.20	0.35	0.08	0.41	0.39	0.47	0.52	0.69	0.84
Std. (in %, from annual returns)	7.45	5.97	6.39	6.97	6.09	5.85	5.11	6.53	7.23	7.81
Pre-ranking Dimson beta	0.93	0.88	0.93	1.05	0.91	0.94	0.97	0.96	0.95	0.90
Post-ranking Dimson beta	1.03	0.88	0.95	0.94	0.85	0.88	0.86	0.84	0.93	0.93
Jensen's Alpha (1 lag, annualized)	-3.94	-1.38	0.13	-3.08	1.32	0.89	1.92	2.60	4.37	6.15
Adj. t-Value	(-2.43)	(-0.78)	(0.09)	(-1.99)	(1.01)	(0.71)	(1.31)	(1.39)	(2.44)	(3.23)
GRS-Test (p-Value)	2.10	(0.02)								
7/1960-6/1990										
Monthly excess return (in %)	-0.05	0.06	0.18	0.12	0.27	0.18	0.32	0.23	0.49	0.66
Std. (in %, from annual returns)	6.17	6.17	6.53	6.97	6.68	5.64	5.40	6.25	6.94	7.03
Pre-ranking Dimson beta	0.99	0.96	1.00	1.05	0.95	0.96	1.01	0.93	0.91	0.89
Post-ranking Dimson beta	0.59	0.63	0.83	0.88	0.87	0.90	0.93	0.95	1.06	1.27
Jensen's Alpha (1 lag, annualized)	-3.75	-2.11	-0.75	-1.67	0.52	-0.73	1.16	0.07	3.09	5.27
Adj. t-Value	(-2.35)	(-1.20)	(-0.47)	(-1.00)	(0.41)	(-0.56)	(0.84)	(0.04)	(1.57)	(2.50)
GRS-Test (p-Value)	1.29	(0.23)								
7/1990-10/2007										
Monthly excess return (in %)	0.19	0.43	0.63	0.01	0.65	0.75	0.72	1.00	1.05	1.16
Std. (in %, from annual returns)	9.50	5.76	6.30	7.17	5.04	6.20	4.66	6.94	7.84	9.14
Pre-ranking Dimson beta	0.83	0.74	0.82	1.04	0.84	0.89	0.91	1.00	1.01	0.90
Post-ranking Dimson beta	1.05	0.80	0.94	0.85	0.79	0.81	0.86	0.77	0.97	1.02
Jensen's Alpha (1 lag, annualized)	-4.33	0.09	1.68	-5.31	2.89	3.91	3.24	7.21	6.51	7.48
Adj. t-Value	(-1.26)	(0.02)	(0.54)	(-1.71)	(1.08)	(1.58)	(1.02)	(1.85)	(1.91)	(1.97)
GRS-Test (p-Value)	1.72	0.08								
Average real market capitalization (in mln. €, in prices of 2007)										
1960-2007	11830	7249	8894	12570	9110	8116	8986	9919	5465	5138
in %	13.55	8.31	10.19	14.40	10.44	9.30	10.30	11.37	6.26	5.89
1960-1990	4459	3157	3285	3638	3248	4258	3488	3164	2301	1417
1990-2007	24115	14070	18242	27456	18880	14546	18149	21177	10737	11339

Table 3, Panel C: Descriptive statistics, BJS and GRS results for Dimson beta sorted decile portfolios.

	Equal-weight portfolios formed on Dimson beta										Value-weight portfolios formed on Dimson beta									
	D01 (Low)	D02	D03	D04	D05	D06	D07	D08	D09	D10 (High)	D01 (Low)	D02	D03	D04	D05	D06	D07	D08	D09	D10 (High)
	7/1960-10/2007										**7/1960-10/2007**									
Monthly excess return (in %)	0.22	0.39	0.43	0.27	0.41	0.47	0.40	0.31	0.28	0.14	0.13	0.54	0.43	0.39	0.50	0.55	0.38	0.28	0.54	0.27
Std. (in %, from annual returns)	3.34	4.41	4.23	4.85	5.46	5.58	6.66	5.64	5.99	7.86	6.99	5.45	4.80	5.65	5.85	7.16	6.82	6.46	7.38	7.24
Pre-ranking Dimson beta	0.17	0.44	0.58	0.70	0.80	0.90	1.00	1.12	1.28	1.64	0.20	0.44	0.59	0.70	0.80	0.90	1.00	1.11	1.27	1.59
Post-ranking Dimson beta	0.46	0.52	0.62	0.66	0.73	0.79	0.88	0.90	0.96	1.14	0.54	0.54	0.64	0.80	0.83	0.82	0.91	0.97	1.12	1.24
Jensen's Alpha (1 lag, annualized)	0.66	2.42	2.54	0.41	1.79	2.30	1.02	-0.07	-0.78	-3.21	-0.77	4.13	2.37	1.33	2.45	3.11	0.68	-0.78	1.73	-2.00
Adj. t-Value	(0.54)	(1.74)	(1.74)	(0.29)	(1.41)	(1.83)	(0.72)	(-0.06)	(-0.56)	(-1.68)	(-0.43)	(2.63)	(1.26)	(0.88)	(1.77)	(2.03)	(0.48)	(-0.54)	(1.17)	(-1.22)
GRS-Test (p-Value)	1.93	(0.04)									1.90	(0.04)								
	7/1960-6/1990										**7/1960-6/1990**									
Monthly excess return (in %)	0.12	0.39	0.40	0.29	0.45	0.45	0.37	0.31	0.30	0.38	-0.06	0.39	0.14	0.27	0.22	0.46	0.32	0.20	0.41	0.18
Std. (in %, from annual returns)	3.49	4.96	4.70	5.35	5.68	5.90	6.43	5.64	5.42	6.55	4.49	6.14	4.50	5.73	5.80	7.75	6.91	5.90	6.39	7.13
Pre-ranking Dimson beta	0.25	0.52	0.65	0.76	0.86	0.95	1.05	1.15	1.28	1.60	0.27	0.52	0.65	0.76	0.86	0.96	1.05	1.15	1.28	1.58
Post-ranking Dimson beta	0.52	0.61	0.77	0.78	0.82	0.84	0.92	0.92	0.99	1.10	0.59	0.63	0.83	0.88	0.87	0.90	0.93	0.95	1.06	1.27
Jensen's Alpha (1 lag, annualized)	-0.18	2.84	2.36	1.07	2.93	2.86	1.67	0.84	0.58	1.10	-2.52	2.69	-0.88	0.54	-0.06	2.78	0.98	-0.55	1.67	-1.80
Adj. t-Value	(-0.13)	(1.63)	(1.63)	(0.80)	(2.22)	(2.27)	(1.14)	(0.61)	(0.42)	(0.74)	(-1.34)	(1.33)	(-0.51)	(0.35)	(-0.05)	(1.72)	(0.69)	(-0.41)	(1.12)	(-1.16)
GRS-Test (p-Value)	1.21	(0.28)									1.18	(0.30)								
	7/1990-10/2007										**7/1990-10/2007**									
Monthly excess return (in %)	0.39	0.38	0.50	0.23	0.34	0.51	0.44	0.32	0.23	-0.27	0.45	0.80	0.92	0.61	0.99	0.70	0.48	0.42	0.77	0.44
Std. (in %, from annual returns)	3.11	3.33	3.37	3.91	5.18	5.15	7.25	5.82	7.06	9.88	10.05	4.05	4.94	5.64	5.79	6.21	6.86	7.53	9.04	7.65
Pre-ranking Dimson beta	0.05	0.32	0.47	0.60	0.71	0.81	0.92	1.06	1.27	1.72	0.08	0.31	0.47	0.60	0.70	0.80	0.92	1.06	1.25	1.60
Post-ranking Dimson beta	0.38	0.40	0.42	0.49	0.62	0.72	0.83	0.87	0.91	1.21	0.47	0.41	0.36	0.68	0.77	0.71	0.87	0.99	1.20	1.19
Jensen's Alpha (1 lag, annualized)	2.35	2.02	3.40	-0.28	0.13	1.54	0.03	-1.57	-3.04	-10.86	2.48	6.98	8.75	3.02	7.00	3.98	0.26	-1.25	1.62	-2.24
Adj. t-Value	(1.05)	(1.08)	(1.46)	(-0.10)	(0.05)	(0.58)	(0.01)	(-0.57)	(-1.02)	(-2.66)	(0.83)	(3.23)	(2.71)	(0.95)	(2.38)	(1.33)	(0.09)	(-0.41)	(0.55)	(-0.66)
GRS-Test (p-Value)	2.08	(0.03)									1.97	(0.04)								
	Average real market capitalization (in mln. €, in prices of 2007)										**Average real market capitalization (in mln. €, in prices of 2007)**									
1960-2007	501	702	863	1735	1968	1488	1484	2034	2397	2800	1972	2870	4127	9115	11227	5881	6183	8577	13113	15276
in %	3.14	4.40	5.40	10.86	12.32	9.32	9.29	12.73	15.01	17.53	2.52	3.66	5.27	11.64	14.33	7.51	7.89	10.95	16.74	19.50
1960-1990	265	398	592	926	966	833	969	958	1074	1221	729	1355	1892	3594	3844	2939	3682	3375	4102	5372
1990-2007	894	1209	1314	3084	3638	2580	2342	3827	4601	5432	4045	5394	7851	18317	23531	10785	10351	17249	28131	31783

Table 4: Descriptive statistics and BJS results for two-dimensional sorted portfolios, first on size (4) then on book-to-market (4).

See Table 3 for a description. Firms are sorted into four size portfolios. Each size portfolio is then subdivided into four book-to-market portfolios, resulting in 16 two-dimensional portfolios. Results for equal-weight portfolios are in panel A, and value-weight portfolios are in panel B. Excess returns, betas, and alphas are based on monthly data.

Panel A: Equal-weight portfolios sorted first on size (column) then on book-to-market (B/M, Row).

		Small	Size		Large	Small	Size		Large	Small	Size		Large	Small	Size		Large	Small	Size		Large
		Excess Return (AM)				Size (Real, in Mio. €)				Full-Period Beta				Alpha (in %, 1 Lag, annualized)				t-Value for Alpha (1 Lag)			
60-07	Low	0.02	0.24	0.15	0.10	70	214	596	4,986	0.59	0.63	0.68	0.93	-2.27	0.13	-1.12	-2.80	-1.44	0.09	-0.82	-2.27
BM		0.17	0.24	0.24	0.31	68	216	601	5,521	0.61	0.72	0.71	0.90	-0.62	-0.26	-0.16	-0.13	-0.40	-0.16	-0.11	-0.11
		0.19	0.40	0.55	0.42	68	207	568	5,824	0.72	0.72	0.77	0.90	-0.87	1.68	3.22	1.16	-0.51	0.97	2.24	1.05
	High	0.40	0.57	0.63	0.72	72	199	570	5,604	0.69	0.81	0.87	0.89	1.83	3.39	3.81	4.83	0.96	2.08	2.15	3.33
60-90	Low	0.16	0.38	0.21	-0.09	58	177	445	2,653	0.65	0.72	0.73	1.00	-0.20	2.36	0.26	-4.21	-0.11	1.34	0.16	-2.92
BM		0.14	0.43	0.24	0.23	56	188	445	2,791	0.65	0.80	0.79	0.98	-0.36	2.66	0.39	-0.22	-0.20	1.57	0.25	-0.17
		0.41	0.36	0.38	0.23	56	179	442	2,962	0.80	0.81	0.88	0.94	2.46	1.77	1.88	-0.08	1.26	1.02	1.16	-0.07
	High	0.73	0.72	0.58	0.44	60	169	460	2,451	0.73	0.83	0.90	0.90	6.48	5.99	4.18	2.49	2.74	3.03	2.07	1.49
90-07	Low	-0.20	-0.01	0.05	0.43	97	290	885	8,889	0.51	0.52	0.61	0.83	-5.69	-3.41	-3.32	-0.09	-1.96	-1.33	-1.40	-0.04
BM		0.22	-0.10	0.25	0.44	92	276	897	10,292	0.56	0.60	0.59	0.77	-0.96	-5.02	-0.80	0.34	-0.32	-1.64	-0.32	0.17
		-0.20	0.47	0.83	0.73	97	267	807	10,768	0.63	0.60	0.62	0.84	-6.42	1.87	5.97	3.49	-2.12	0.52	2.28	1.62
	High	-0.17	0.33	0.71	1.21	96	263	789	11,124	0.65	0.78	0.84	0.87	-6.16	-1.05	3.24	8.96	-2.00	-0.37	0.96	3.33

Panel B: Value-weight portfolios sorted first on size (column) then on book-to-market (B/M, Row).

		Small	Size		Large	Small	Size		Large	Small	Size		Large	Small	Size		Large	Small	Size		Large
		Excess Return (AM)				Size (Real, in Mio. €)				Full-Period Beta				Alpha (in %, 1 Lag, annualized)				t-Value for Alpha (1 Lag)			
60-07	Low	0.06	0.30	0.05	0.21	80	230	657	12,650	0.57	0.61	0.67	1.11	-1.74	0.95	-2.28	-2.25	-1.10	0.60	-1.59	-1.60
BM		0.17	0.24	0.23	0.33	77	233	659	14,262	0.62	0.71	0.70	0.95	-0.62	-0.19	-0.29	-0.08	-0.40	-0.13	-0.21	-0.07
		0.15	0.47	0.49	0.35	78	224	624	12,353	0.73	0.71	0.78	0.96	-1.36	2.59	2.55	0.15	-0.78	1.58	1.79	0.14
	High	0.44	0.58	0.63	0.65	81	214	630	12,129	0.67	0.82	0.88	0.93	2.37	3.41	3.73	3.81	1.12	2.00	2.02	2.65
60-90	Low	0.15	0.40	0.16	0.02	67	190	473	6,101	0.65	0.71	0.75	1.16	-0.31	2.56	-0.46	-3.37	-0.17	1.36	-0.27	-2.18
BM		0.13	0.38	0.17	0.20	64	201	472	5,438	0.64	0.77	0.77	0.93	-0.43	2.14	-0.33	-0.40	-0.24	1.31	-0.21	-0.33
		0.32	0.38	0.33	0.26	63	192	469	5,423	0.82	0.80	0.87	0.96	1.23	2.06	1.27	0.21	0.58	1.17	0.78	0.17
	High	0.74	0.66	0.55	0.39	68	181	489	3,546	0.67	0.85	0.91	0.91	6.82	5.32	3.76	1.85	2.53	2.59	1.75	1.10
90-07	Low	-0.08	0.13	-0.13	0.54	108	312	1,001	23,414	0.50	0.53	0.53	1.03	-3.96	-1.50	-5.15	x	-1.36	-0.58	-2.16	-0.04
BM		0.24	0.00	0.33	0.55	105	301	1,005	29,465	0.62	0.65	0.62	1.00	-0.86	-4.04	0.01	0.42	-0.30	-1.34	0.00	0.16
		-0.14	0.63	0.77	0.51	109	291	914	24,319	0.64	0.58	0.64	0.88	-5.54	3.86	5.16	0.06	-1.95	1.21	2.00	0.03
	High	-0.08	0.43	0.76	1.10	107	282	902	26,795	0.73	0.75	0.86	0.98	-5.36	0.22	3.78	7.15	-1.59	0.08	1.10	2.72

Table 5: Descriptive statistics and BJS results for two-dimensional sorted portfolios, first on book-to-market (4) then size (4).

See Table 3 for a description. Firms are sorted into four book-to-market portfolios. Each book-to-market portfolio is then subdivided into four size portfolios, resulting in 16 two-dimensional portfolios. Results for equal-weight portfolios are in panel A, and value-weight portfolios are in panel B.

Panel A: Equal-weight portfolios sorted first on book-to-market (B/M, Row) then on size (column).

		Small	Size		Large	Small	Size		Large	Small	Size		Large	Small	Size		Large	Small	Size		Large
		Excess Return (AM)				**Size (Real, in Mio. €)**				**Full-Period Beta**				**Alpha (in %, 1 Lag, annualized)**				**t-Value for Alpha (1 Lag)**			
60-07	Low	0.10	0.20	0.15	0.08	94	310	832	5,900	0.58	0.66	0.73	0.86	-1.36	-0.42	-1.31	-2.77	-0.85	-0.29	-0.96	-2.29
	B/M	0.04	0.35	0.40	0.33	85	290	814	6,509	0.62	0.70	0.80	0.90	-2.21	1.22	1.40	0.10	-1.39	0.81	0.97	0.09
		0.33	0.14	0.53	0.40	70	203	635	5,769	0.68	0.74	0.81	0.88	0.99	-1.53	2.92	1.04	0.59	-0.87	1.97	0.88
	High	0.32	0.57	0.66	0.74	71	186	462	3,663	0.72	0.77	0.82	0.90	0.70	3.54	4.43	5.06	0.39	2.09	2.53	3.40
60-90	Low	0.24	0.24	0.25	-0.08	70	208	449	2,561	0.64	0.71	0.76	0.93	0.87	0.64	0.70	-3.78	0.48	0.36	0.43	-2.69
	B/M	0.03	0.47	0.30	0.12	64	215	521	2,752	0.67	0.75	0.91	0.98	-1.79	3.33	0.86	-1.50	-1.01	2.01	0.50	-1.16
		0.58	0.07	0.47	0.12	58	168	473	3,064	0.77	0.85	0.92	0.93	4.58	-1.75	2.74	-1.47	2.34	-0.94	1.70	-1.16
	High	0.69	0.80	0.66	0.46	63	181	473	2,462	0.73	0.81	0.86	0.89	6.02	7.12	5.20	2.74	2.79	3.52	2.60	1.61
90-07	Low	-0.15	0.14	-0.02	0.34	144	498	1,507	11,463	0.51	0.58	0.70	0.76	-5.02	-2.07	-4.70	-0.77	-1.71	-0.89	-1.93	-0.35
	B/M	0.06	0.15	0.57	0.68	126	438	1,358	13,011	0.54	0.65	0.63	0.78	-2.77	-2.30	2.77	3.18	-0.90	-0.81	1.11	1.51
		-0.12	0.25	0.65	0.89	94	270	919	10,420	0.55	0.58	0.65	0.80	-4.91	-0.74	3.68	5.61	-1.68	-0.21	1.32	2.46
	High	-0.33	0.17	0.67	1.24	90	207	481	5,952	0.71	0.72	0.76	0.92	-8.53	-2.55	3.24	9.07	-2.76	-0.86	1.00	3.25

Panel B: Value-weight portfolios sorted first on book-to-market (B/M, Row) then on size (column).

		Small	Size		Large	Small	Size		Large	Small	Size		Large	Small	Size		Large	Small	Size		Large
		Excess Return (AM)				**Size (Real, in Mio. €)**				**Full-Period Beta**				**Alpha (in %, 1 Lag, annualized)**				**t-Value for Alpha (1 Lag)**			
60-07	Low	0.23	0.19	0.11	0.16	114	341	933	12,706	0.57	0.64	0.76	1.10	0.35	-0.46	-1.88	-2.75	0.21	-0.30	-1.35	-2.06
	B/M	0.05	0.33	0.40	0.25	104	320	921	14,334	0.62	0.68	0.79	0.97	-2.04	1.05	1.44	-1.11	-1.24	0.70	0.98	-0.96
		0.27	0.19	0.53	0.49	81	222	778	13,035	0.70	0.71	0.80	0.88	0.19	-0.81	2.96	2.10	0.12	-0.49	1.93	1.80
	High	0.32	0.56	0.66	0.71	80	201	506	9,492	0.69	0.78	0.80	1.00	0.90	3.40	4.51	4.20	0.47	1.92	2.50	2.46
60-90	Low	0.22	0.25	0.20	0.00	84	224	471	6,245	0.63	0.70	0.76	1.15	0.66	0.88	0.07	-3.54	0.36	0.47	0.04	-2.38
	B/M	0.03	0.41	0.28	0.12	78	233	570	5,232	0.68	0.73	0.91	0.98	-1.79	2.58	0.61	-1.55	-0.96	1.56	0.36	-1.19
		0.54	0.09	0.45	0.28	68	179	547	5,531	0.79	0.83	0.92	0.91	3.99	-1.50	2.53	0.56	2.03	-0.80	1.58	0.45
	High	0.75	0.81	0.67	0.38	72	198	511	3,596	0.66	0.82	0.84	0.89	6.93	7.22	5.38	1.82	2.86	3.44	2.56	1.08
90-07	Low	0.26	0.09	-0.04	0.45	175	553	1,741	23,295	0.47	0.56	0.76	1.04	0.07	-2.56	-5.26	-1.21	0.02	-1.08	-2.18	-0.47
	B/M	0.10	0.21	0.61	0.48	154	491	1,567	29,991	0.54	0.62	0.63	0.95	-2.25	-1.44	3.32	-0.29	-0.71	-0.50	1.30	-0.13
		-0.20	0.36	0.68	0.85	108	299	1,175	25,980	0.58	0.54	0.62	0.84	-6.11	0.85	4.17	4.87	-2.22	0.29	1.42	2.09
	High	-0.41	0.13	0.65	1.27	98	218	537	19,669	0.75	0.73	0.73	1.16	-9.72	-3.11	3.19	7.97	-3.22	-1.01	0.97	2.22

Table 6: Results for long-term GRS tests.

In panel A, we form one-dimensional groups sorting firms on size, Dimson beta and book-to-market (B/M). We form 10, 16, and 20 portfolios. We do not include size portfolio D01 when we calculate the GRS test statistics for size deciles. In Panel B we form two-dimensional sorted portfolios using firms' characteristics. We present results for 9 (3*3), 16 (4*4), and 25 (5*5) two-dimensional sorted portfolios. The GRS p-values are based on monthly and quarterly data for the overall period from July 1960 to October 2007, and for the two subperiods, 7/1960-6/1990 and 71990-10/2007. For annual data we only look at the full period from July 1960 to June 2007. We also present results from equal-weight and value-weight portfolios. For monthly return intervals we apply an extended model of the BJS time-series regression to estimate Jensen's alphas and variance-covariance matrix of the residuals, where we include the one-period lagged market excess rate of return in the regression. For quarterly and annual data we use the standard test procedure. P-values below .10 are highlighted.

Panel A: GRS p-values for one-dimensional sorted portfolios.

Return	EW portfolios			VW portfolios			EW portfolios			VW portfolios			EW portfolios			VW portfolios		
interval	60-07	60-90	90-07	60-07	60-90	90-07	60-07	60-90	90-07	60-07	60-90	90-07	60-07	60-90	90-07	60-07	60-90	90-07
	9 size portfolios (w/o D01)						16 size portfolios						20 size portfolios					
monthly	0.41	0.10	0.03	0.34	0.34	0.02	0.06	0.12	0.05	0.28	0.27	0.11	0.08	0.36	0.01	0.35	0.72	0.01
quarterly	0.43	0.15	0.06	0.44	0.41	0.07	0.14	0.18	0.14	0.34	0.38	0.15	0.14	0.25	0.04	0.40	0.56	0.01
annual	0.84			0.87			0.07			0.32			0.90			0.98		
	10 Dimson portfolios						16 Dimson portfolios						20 Dimson portfolios					
monthly	0.04	0.28	0.03	0.04	0.30	0.04	0.01	0.21	0.02	0.21	0.22	0.29	0.05	0.36	0.02	0.00	0.07	0.02
quarterly	0.05	0.35	0.02	0.10	0.22	0.05	0.01	0.19	0.01	0.46	0.17	0.23	0.23	0.48	0.28	0.04	0.24	0.14
annual	0.35			0.47			0.06			0.59			0.80			0.42		
	10 B/M portfolios						20 B/M portfolios						20 B/Mportfolios					
monthly	0.04	0.02	0.45	0.02	0.23	0.08	0.11	0.11	0.50	0.02	0.17	0.17	0.31	0.34	0.55	0.07	0.51	0.16
quarterly	0.06	0.05	0.23	0.04	0.27	0.09	0.20	0.26	0.33	0.03	0.35	0.10	0.29	0.56	0.50	0.07	0.62	0.14
annual	0.21			0.30			0.42			0.21			0.55			0.04		

Panel B: GRS p-values for two-dimensional sorted portfolios.

Return	EW portfolios			VW portfolios			EW portfolios			VW portfolios			EW portfolios			VW portfolios		
interval	60-07	60-90	90-07	60-07	60-90	90-07	60-07	60-90	90-07	60-07	60-90	90-07	60-07	60-90	90-07	60-07	60-90	90-07
	9 size, B/M portfolios						16 size, B/M portfolios						25 size, B/M portfolios					
monthly	0.00	0.00	0.00	0.03	0.10	0.00	0.02	0.02	0.01	0.06	0.27	0.02	0.01	0.00	0.11	0.08	0.06	0.04
quarterly	0.01	0.00	0.03	0.10	0.14	0.05	0.08	0.05	0.10	0.20	0.34	0.15	0.08	0.02	0.44	0.34	0.21	0.22
annual	0.02			0.28			0.23			0.77			0.56			0.65		
	9 B/M, size portfolios						16 B/M, size portfolios						25 B/M, size portfolios					
monthly	0.05	0.01	0.00	0.19	0.15	0.03	0.01	0.00	0.00	0.04	0.02	0.00	0.17	0.13	0.00	0.08	0.27	0.00
quarterly	0.11	0.05	0.00	0.27	0.25	0.11	0.02	0.00	0.02	0.07	0.04	0.02	0.20	0.17	0.00	0.15	0.55	0.00
annual	0.35			0.64			0.03			0.35			0.04			0.22		
	9 size, beta portfolios						16 size, beta portfolios						25 size, beta portfolios					
monthly	0.09	0.07	0.00	0.15	0.42	0.00	0.14	0.64	0.00	0.29	0.80	0.00	0.34	0.21	0.00	0.16	0.33	0.00
quarterly	0.20	0.12	0.00	0.28	0.46	0.00	0.22	0.40	0.00	0.27	0.69	0.04	0.16	0.13	0.08	0.17	0.35	0.09
annual	0.56			0.64			0.62			0.83			0.65			0.67		
	9 beta, size portfolios						16 beta, size portfolios						25 beta, size portfolios					
monthly	0.01	0.02	0.00	0.02	0.21	0.00	0.07	0.14	0.00	0.13	0.61	0.00	0.08	0.43	0.00	0.14	0.80	0.00
quarterly	0.03	0.05	0.00	0.05	0.21	0.00	0.11	0.20	0.00	0.30	0.58	0.00	0.18	0.27	0.00	0.24	0.66	0.02
annual	0.18			0.19			0.64			0.79			0.80			0.68		
	9 B/M, beta portfolios						16 B/M, beta portfolios						25 B/M, beta portfolios					
monthly	0.00	0.05	0.02	0.25	0.37	0.16	0.01	0.13	0.02	0.01	0.14	0.01	0.01	0.04	0.02	0.00	0.05	0.00
quarterly	0.02	0.15	0.11	0.40	0.34	0.26	0.01	0.16	0.05	0.02	0.28	0.00	0.01	0.04	0.14	0.00	0.19	0.00
annual	0.11			0.56			0.07			0.07			0.27			0.13		
	9 beta, B/M portfolios						16 beta, B/M portfolios						25 beta, B/M portfolios					
monthly	0.00	0.01	0.00	0.06	0.17	0.07	0.00	0.04	0.01	0.18	0.26	0.00	0.00	0.04	0.01	0.18	0.26	0.00
quarterly	0.01	0.03	0.01	0.18	0.25	0.16	0.03	0.15	0.07	0.30	0.32	0.03	0.03	0.15	0.07	0.30	0.32	0.03
annual	0.10			0.22			0.32			0.35			0.04			0.50		

Table 7: Results for short-term (5-yr periods) GRS tests.

We calculate GRS p-values based on monthly data for each of the five year periods from July 1960 to October 2007. The last period, however, extends only from July 2005 to October 2007. In panel A, we present p-values for 10, 16, and 20 one-dimensional portfolios sorted on size, beta, and book-to-market (BM). In panel B, we present p-values for 9 (3*3), 16 (4*4), and 25 (5*5) two-dimensional portfolios sorted first on size and then on book-to-market and vice versa. We present GRS p-values for equal-weight and value-weight portfolios. The last three columns present average p-values for the overall period from 7/1960 to 10/2007 and the two subperiods, 7/1960-6/1990 and 7/1990-10/2007. The alphas and residuals for the GRS test are estimated using the extended BJS model (see equation 1 in section 4.1). P-values below .1 are highlighted.

Panel A: 5-yr GRS p-values of one-dimensional sorted portfolios (size, beta, BM)

Portfolios	60-65	65-70	70-75	75-80	80-85	85-90	90-95	95-00	00-05	05-07	60-07	60-90	90-07
10 EW Size	0.494	0.224	0.656	0.227	0.906	0.124	0.456	0.301	0.004	0.329	0.372	0.438	0.272
16 EW Size	0.584	0.705	0.756	0.501	0.717	0.652	0.419	0.221	0.005	0.424	0.267	0.498	0.652
20 EW Size	0.134	0.866	0.120	0.032	0.965	0.220	0.232	0.159	0.000	0.727	0.280	0.346	0.389
10 EW Beta	0.506	0.436	0.644	0.450	0.898	0.025	0.001	0.165	0.015	0.788	0.242	0.393	0.493
16 EW Beta	0.414	0.704	0.614	0.131	0.837	0.366	0.021	0.586	0.094	0.822	0.380	0.459	0.511
20 EW Beta	0.556	0.726	0.934	0.220	0.656	0.165	0.185	0.670	0.008	0.538	0.350	0.466	0.543
10 EW BM	0.943	0.119	0.572	0.973	0.847	0.085	0.396	0.332	0.034	0.515	0.319	0.482	0.590
16 EW BM	0.584	0.392	0.417	0.511	0.857	0.197	0.651	0.309	0.071	0.806	0.459	0.479	0.493
20 EW BM	0.774	0.669	0.139	0.822	0.899	0.632	0.083	0.220	0.264	0.892	0.365	0.539	0.656
10 VW Size	0.824	0.187	0.777	0.194	0.803	0.108	0.589	0.647	0.001	0.840	0.497	0.482	0.519
16 VW Size	0.604	0.453	0.785	0.489	0.328	0.685	0.238	0.349	0.042	0.792	0.476	0.557	0.355
20 VW Size	0.150	0.709	0.226	0.049	0.911	0.264	0.131	0.344	0.000	0.801	0.358	0.385	0.319
10 VW Beta	0.554	0.281	0.167	0.847	0.690	0.027	0.008	0.568	0.034	0.911	0.409	0.428	0.380
16 VW Beta	0.344	0.287	0.287	0.727	0.759	0.278	0.002	0.267	0.101	0.949	0.400	0.447	0.330
20 VW Beta	0.886	0.169	0.824	0.081	0.986	0.329	0.055	0.637	0.003	0.044	0.401	0.546	0.185
10 VW BM	0.449	0.176	0.005	0.730	0.611	0.384	0.665	0.600	0.019	0.486	0.413	0.393	0.442
16 VW BM	0.235	0.382	0.371	0.944	0.361	0.483	0.452	0.747	0.048	0.695	0.472	0.462	0.485
20 VW BM	0.651	0.430	0.442	0.923	0.877	0.437	0.797	0.388	0.036	0.414	0.539	0.627	0.409
Avg. EW	0.554	0.538	0.539	0.430	0.842	0.274	0.271	0.329	0.055	0.649	0.337	0.455	0.511
Avg. VW	0.522	0.341	0.431	0.554	0.703	0.333	0.326	0.505	0.031	0.659	0.441	0.481	0.380

Panel B: 5-yr GRS p-values of two-dimensional sorted portfolios (size, BM and BM, size)

Portfolios	60-65	65-70	70-75	75-80	80-85	85-90	90-95	95-00	00-05	05-07	60-07	60-90	90-07
9 EW Size, BM	0.504	0.221	0.012	0.394	0.963	0.053	0.223	0.407	0.000	0.452	0.323	0.358	0.270
16 EW Size, BM	0.699	0.061	0.256	0.475	0.978	0.230	0.023	0.106	0.000	0.201	0.303	0.450	0.083
25 EW Size, BM	0.096	0.649	0.028	0.059	0.157	0.031	0.583	0.118	0.011	0.882	0.261	0.170	0.398
9 VW Size, BM	0.269	0.246	0.097	0.327	0.987	0.028	0.184	0.509	0.000	0.672	0.332	0.325	0.341
16 VW Size, BM	0.664	0.294	0.840	0.258	0.993	0.106	0.044	0.979	0.000	0.734	0.491	0.526	0.439
25 VW Size, BM	0.057	0.642	0.171	0.099	0.176	0.017	0.205	0.058	0.002	0.225	0.165	0.194	0.123
9 EW BM, Size	0.384	0.068	0.029	0.875	0.971	0.034	0.190	0.005	0.000	0.647	0.320	0.393	0.210
16 EW BM, Size	0.319	0.119	0.005	0.266	0.952	0.105	0.386	0.064	0.000	0.039	0.225	0.294	0.122
25 EW BM, Size	0.270	0.126	0.246	0.543	0.691	0.153	0.666	0.508	0.010	0.048	0.326	0.338	0.308
9 VW BM, Size	0.223	0.113	0.180	0.696	0.998	0.044	0.083	0.088	0.000	0.866	0.329	0.376	0.259
16 VW BM, Size	0.130	0.572	0.050	0.268	0.924	0.214	0.212	0.214	0.000	0.515	0.310	0.360	0.235
25 VW BM, Size	0.355	0.099	0.177	0.220	0.760	0.235	0.779	0.257	0.001	0.559	0.344	0.307	0.399
Avg. EW	0.379	0.207	0.096	0.435	0.785	0.101	0.345	0.201	0.004	0.378	0.293	0.334	0.232
Avg. VW	0.283	0.328	0.252	0.311	0.806	0.107	0.251	0.351	0.001	0.595	0.329	0.348	0.299

Table 8: Results for cross-sectional FM regressions with one independent variable for one-dimensional sorted portfolios.

The table presents average intercepts (annualized alphas in %) and slopes on firm/portfolio characteristics (also annualized in%) from cross-sectional FM regressions of excess returns on size, book-to-market, or beta. The independent variable in the regression matches the grouping criterion. We look at individual firms and at portfolios grouped by size, book-to-market, and beta. Specification: We use monthly (M), quarterly (Q) and annual (A) excess rates of return as dependent variable in the regressions. We look at individual firms, but also form 10, 16, and 20 portfolios. We apply different beta estimation procedures for our beta groups. We use monthly (MFP), quarterly (QFP), and annual (AFP) full-period betas. In addition we use 5-yr rolling betas on a monthly (MRB) and quarterly (QRB) basis. Monthly betas are estimated according to Dimson (1979) using the lagged market excess return. In firm level regressions á la *Fama/French* (1992) we assign portfolios' full period betas to the firms in the portfolio. MFP10 for example indicates that we form 10 portfolios and assign portfolios' full period beta to every firm in the portfolio. Results for equal-weight portfolios are presented on the left side of the table, and for value-weight portfolios on the right side. We look at the overall period from 7/1960 to 10/2007, as well as two subperiods, 7/1960-6/1990 and 7/1990-10/2007. The t-values for the intercepts and slopes are presented in parentheses. T-values above/below ± 1.96 are highlighted.

	Equal-weight size portfolios												Value-weight size portfolios											
	7/1960-10/2007				7/1960-6/1990				7/1990-10/2007				7/1960-10/2007				7/1960-6/1990				7/1990-10/2007			
Specification	Intercept		Size		Intercept		Size		Intercept		Size		Intercept		Size		Intercept		Size		Intercept		Size	
M firms	0.64	(0.27)	0.45	(1.17)	6.74	(2.47)	-0.56	(-1.20)	-9.93	(-2.41)	2.19	(3.47)	0.64	(0.27)	0.45	(1.17)	6.74	(2.47)	-0.56	(-1.20)	-9.93	(-2.41)	2.19	(3.47)
Q firms	0.37	(0.13)	0.54	(1.31)	7.00	(2.21)	-0.56	(-1.21)	-11.16	(-2.12)	2.45	(3.35)	0.37	(0.13)	0.54	(1.31)	7.00	(2.21)	-0.56	(-1.21)	-11.16	(-2.12)	2.45	(3.35)
M 9	1.07	(0.47)	0.36	(0.97)	7.14	(2.66)	-0.65	(-1.41)	-9.44	(-2.34)	2.10	(3.45)	1.46	(0.63)	0.33	(0.88)	6.59	(2.41)	-0.51	(-1.12)	-7.43	(-1.79)	1.78	(2.79)
M 16	0.56	(0.24)	0.46	(1.21)	6.85	(2.46)	-0.57	(-1.21)	-10.33	(-2.49)	2.25	(3.55)	1.15	(0.49)	0.36	(0.94)	6.18	(2.21)	-0.46	(-0.95)	-7.57	(-1.84)	1.79	(2.83)
M 20	0.70	(0.30)	0.44	(1.13)	7.00	(2.48)	-0.60	(-1.24)	-10.20	(-2.45)	2.23	(3.54)	1.10	(0.47)	0.38	(0.98)	6.18	(2.19)	-0.46	(-0.93)	-7.70	(-1.89)	1.83	(2.90)
Q 9	1.46	(0.53)	0.35	(0.90)	7.55	(2.46)	-0.67	(-1.50)	-9.12	(-1.79)	2.12	(3.14)	1.79	(0.64)	0.33	(0.82)	6.99	(2.24)	-0.54	(-1.21)	-7.26	(-1.38)	1.83	(2.49)
Q 16	0.90	(0.32)	0.46	(1.16)	7.25	(2.30)	-0.59	(-1.31)	-10.16	(-1.96)	2.29	(3.26)	1.46	(0.52)	0.36	(0.90)	6.59	(2.09)	-0.49	(-1.06)	-7.46	(-1.44)	1.84	(2.55)
Q 20	1.06	(0.37)	0.43	(1.07)	7.42	(2.31)	-0.63	(-1.34)	-10.01	(-1.91)	2.27	(3.21)	1.39	(0.50)	0.38	(0.94)	6.57	(2.06)	-0.48	(-1.02)	-7.62	(-1.49)	1.88	(2.65)
A 9	2.35	(0.69)	0.27	(0.59)	8.19	(2.03)	-0.71	(-1.19)	-7.95	(-1.44)	2.02	(3.89)	2.70	(0.77)	0.27	(0.55)	7.51	(1.81)	-0.54	(-0.85)	-5.79	(-0.98)	1.69	(2.56)
A 16	1.85	(0.51)	0.39	(0.78)	7.89	(1.86)	-0.62	(-0.98)	-8.80	(-1.50)	2.17	(3.69)	2.42	(0.69)	0.29	(0.59)	7.13	(1.68)	-0.50	(-0.77)	-5.89	(-1.01)	1.69	(2.61)
A 20	2.14	(0.59)	0.34	(0.68)	8.20	(1.86)	-0.68	(-1.04)	-8.56	(-1.50)	2.14	(3.85)	2.38	(0.67)	0.32	(0.63)	7.22	(1.64)	-0.50	(-0.75)	-6.15	(-1.09)	1.76	(2.83)

	Equal-weight book-to-market portfolios												Value-weight book-to-market portfolios											
	Intercept		B/M		Intercept		B/M		Intercept		B/M		Intercept		B/M		Intercept		B/M		Intercept		B/M	
M firms	5.56	(2.68)	2.98	(3.74)	6.13	(2.38)	3.58	(3.19)	4.56	(1.31)	1.94	(1.99)	5.56	(2.68)	2.98	(3.74)	6.13	(2.38)	3.58	(3.19)	4.56	(1.31)	1.94	(1.99)
Q firms	5.86	(2.32)	3.05	(3.39)	6.53	(2.14)	3.90	(3.17)	4.69	(1.04)	1.58	(1.29)	5.86	(2.32)	3.05	(3.39)	6.53	(2.14)	3.90	(3.17)	4.69	(1.04)	1.58	(1.29)
M 10	5.75	(2.76)	3.43	(4.02)	6.42	(2.49)	4.22	(3.53)	4.59	(1.30)	2.06	(1.93)	7.62	(3.12)	4.64	(3.62)	5.30	(1.86)	4.15	(2.59)	11.63	(2.60)	5.49	(2.56)
M 16	5.65	(2.71)	3.28	(3.83)	6.34	(2.46)	4.06	(3.40)	4.45	(1.26)	1.94	(1.77)	7.40	(3.11)	4.53	(3.78)	5.21	(1.84)	4.17	(2.78)	11.21	(2.63)	5.17	(2.57)
M 20	5.70	(2.75)	3.36	(3.85)	6.40	(2.49)	4.19	(3.41)	4.47	(1.28)	1.92	(1.80)	7.43	(3.15)	4.54	(3.82)	5.52	(1.96)	4.25	(2.82)	10.72	(2.56)	5.05	(2.61)
Q 10	6.26	(2.46)	3.67	(3.82)	6.83	(2.24)	4.43	(3.36)	5.25	(1.15)	2.34	(1.81)	8.10	(2.85)	4.77	(3.53)	5.70	(1.74)	4.38	(2.62)	12.29	(2.31)	5.45	(2.36)
Q 16	6.16	(2.42)	3.54	(3.62)	6.77	(2.22)	4.29	(3.23)	5.11	(1.12)	2.22	(1.66)	7.90	(2.81)	4.73	(3.58)	5.64	(1.72)	4.50	(2.73)	11.81	(2.28)	5.13	(2.31)
Q 20	6.20	(2.44)	3.62	(3.69)	6.80	(2.24)	4.42	(3.27)	5.14	(1.13)	2.23	(1.71)	7.91	(2.87)	4.71	(3.66)	5.94	(1.83)	4.52	(2.76)	11.34	(2.25)	5.04	(2.40)
A 10	6.82	(2.31)	4.00	(3.53)	7.40	(2.05)	4.83	(3.23)	5.78	(1.11)	2.54	(1.51)	8.41	(2.62)	4.96	(2.83)	6.12	(1.59)	4.45	(2.22)	12.44	(2.16)	5.87	(1.73)
A 16	6.72	(2.28)	3.87	(3.34)	7.34	(2.04)	4.69	(3.08)	5.63	(1.07)	2.44	(1.38)	8.25	(2.59)	4.98	(2.92)	6.03	(1.61)	4.58	(2.39)	12.16	(2.09)	5.69	(1.70)
A 20	6.73	(2.30)	3.93	(3.34)	7.34	(2.05)	4.78	(3.05)	5.66	(1.09)	2.43	(1.42)	8.30	(2.65)	5.04	(3.12)	6.36	(1.71)	4.61	(2.40)	11.74	(2.05)	5.79	(1.95)

Table 8 cont.

			Equal-weight Dimson beta portfolios												Value-weight Dimson beta portfolios											
			7/1960-10/2007				7/1960-6/1990				7/1990-10/2007				7/1960-10/2007				7/1960-6/1990				7/1990-10/2007			
Specification			Intercept		Beta		Intercept		Beta		Intercept		Beta		Intercept		Beta		Intercept		Beta		Intercept		Beta	
M	firms	MFP10	5.28	(3.12)	-1.73	(-0.52)	1.56	(0.67)	3.13	(0.74)	8.27	(3.83)	-6.76	(-1.27)	5.74	(3.39)	-2.13	(-0.71)	2.02	(0.89)	2.37	(0.64)	8.12	(3.93)	-5.82	(-1.26)
M	firms	MFP16	5.31	(3.12)	-1.78	(-0.54)	1.72	(0.74)	2.94	(0.70)	8.11	(3.68)	-6.59	(-1.24)	5.62	(3.46)	-2.00	(-0.69)	1.99	(0.87)	2.42	(0.64)	7.88	(3.93)	-5.55	(-1.28)
M	firms	MFP20	5.39	(3.15)	-1.80	(-0.54)	2.02	(0.90)	2.61	(0.64)	8.10	(3.69)	-6.43	(-1.21)	5.52	(3.21)	-1.84	(-0.62)	2.32	(0.95)	2.08	(0.52)	6.92	(3.36)	-4.17	(-0.99)
Q	firms	QFP10	4.44	(2.52)	-0.30	(-0.09)	2.17	(0.87)	2.67	(0.68)	6.15	(3.02)	-3.41	(-0.56)	4.57	(2.65)	-0.41	(-0.14)	2.35	(0.93)	2.25	(0.62)	6.12	(3.27)	-2.74	(-0.58)
Q	firms	QFP16	4.00	(2.29)	0.31	(0.09)	1.30	(0.51)	3.73	(0.91)	5.60	(2.72)	-2.50	(-0.42)	4.35	(2.60)	-0.15	(-0.05)	1.94	(0.76)	2.70	(0.72)	5.88	(3.18)	-2.42	(-0.54)
Q	firms	QFP20	4.09	(2.36)	0.22	(0.07)	1.99	(0.80)	2.91	(0.73)	5.45	(2.73)	-2.22	(-0.37)	4.36	(2.54)	-0.15	(-0.05)	2.59	(0.98)	2.01	(0.53)	5.43	(2.96)	-1.80	(-0.40)
M	10	MFP	5.50	(3.22)	-1.98	(-0.59)	2.05	(0.87)	2.56	(0.61)	8.19	(3.78)	-6.65	(-1.26)	4.75	(1.92)	0.06	(0.02)	1.07	(0.32)	2.19	(0.46)	10.17	(3.11)	-3.00	(-0.50)
M	10	AFP	4.95	(3.31)	-1.15	(-0.38)	0.93	(0.46)	4.25	(1.08)	7.59	(3.88)	-5.47	(-1.31)	4.11	(1.48)	0.83	(0.20)	-1.96	(-0.68)	5.73	(1.45)	11.97	(3.49)	-4.98	(-1.02)
M	10	MRB	6.53	(3.61)	-3.55	(-1.03)	4.94	(1.91)	-0.52	(-0.12)	9.30	(4.39)	-8.78	(-1.52)	3.46	(1.55)	1.11	(0.33)	0.52	(0.17)	2.40	(0.56)	8.56	(2.71)	-1.12	(-0.20)
M	16	MFP	5.69	(3.27)	-2.20	(-0.66)	2.37	(1.00)	2.23	(0.54)	8.10	(3.62)	-6.58	(-1.24)	4.38	(1.83)	0.42	(0.11)	0.07	(0.02)	3.36	(0.71)	8.84	(2.93)	-1.64	(-0.28)
M	16	AFP	4.80	(3.07)	-0.92	(-0.31)	0.94	(0.45)	4.26	(1.15)	7.37	(3.58)	-5.25	(-1.22)	4.32	(1.79)	0.52	(0.14)	-0.07	(-0.03)	3.56	(1.01)	9.16	(3.13)	-1.90	(-0.41)
M	16	MRB	5.29	(3.22)	-2.26	(-0.71)	3.23	(1.41)	1.33	(0.35)	8.86	(4.24)	-8.47	(-1.50)	2.52	(1.25)	2.04	(0.62)	-0.46	(-0.17)	3.57	(0.89)	7.68	(2.65)	-0.61	(-0.11)
M	20	MFP	5.71	(3.19)	-2.17	(-0.65)	2.92	(1.23)	1.60	(0.39)	7.82	(3.46)	-6.13	(-1.15)	3.65	(1.51)	1.36	(0.36)	0.27	(0.08)	3.00	(0.65)	7.39	(2.34)	0.80	(0.14)
M	20	AFP	5.25	(3.25)	-1.47	(-0.48)	0.63	(0.30)	4.69	(1.23)	7.65	(3.69)	-5.57	(-1.37)	2.13	(0.92)	3.24	(0.95)	-0.50	(-0.20)	3.91	(1.18)	6.63	(2.16)	2.06	(0.50)
M	20	MRB	5.66	(3.41)	-2.65	(-0.84)	3.66	(1.58)	0.80	(0.21)	9.11	(4.37)	-8.63	(-1.54)	1.16	(0.60)	3.75	(1.22)	-1.51	(-0.59)	4.54	(1.21)	5.78	(2.04)	2.39	(0.45)
Q	10	QFP	5.00	(2.79)	-0.86	(-0.23)	1.90	(0.76)	3.13	(0.73)	7.12	(3.32)	-4.62	(-0.71)	4.12	(1.63)	1.19	(0.31)	0.36	(0.10)	3.20	(0.65)	8.79	(2.68)	-0.49	(-0.08)
Q	10	AFP	4.67	(2.76)	-0.42	(-0.12)	1.06	(0.49)	4.45	(1.15)	7.00	(3.31)	-4.28	(-0.83)	3.94	(1.35)	1.37	(0.32)	-1.89	(-0.63)	5.87	(1.51)	11.59	(3.26)	-3.94	(-0.69)
Q	10	QRB	5.54	(3.21)	-1.98	(-0.58)	3.80	(1.58)	0.85	(0.24)	8.55	(3.97)	-6.91	(-0.97)	4.34	(1.83)	0.64	(0.21)	1.90	(0.60)	1.22	(0.34)	8.58	(2.52)	-0.38	(-0.07)
Q	16	QFP	5.15	(2.81)	-1.07	(-0.29)	2.14	(0.82)	2.87	(0.65)	6.99	(3.19)	-4.50	(-0.69)	3.70	(1.53)	1.66	(0.44)	-0.17	(-0.04)	3.86	(0.75)	7.66	(2.70)	0.74	(0.12)
Q	16	AFP	4.49	(2.55)	-0.16	(-0.05)	1.05	(0.48)	4.47	(1.21)	6.70	(3.05)	-3.93	(-0.74)	4.13	(1.66)	1.14	(0.30)	-0.03	(-0.01)	3.75	(1.05)	8.84	(3.03)	-0.83	(-0.16)
Q	16	QRB	4.65	(2.82)	-1.03	(-0.32)	2.27	(1.00)	2.65	(0.88)	8.80	(4.16)	-7.43	(-1.07)	4.20	(2.12)	0.98	(0.38)	1.52	(0.58)	1.98	(0.69)	8.86	(3.12)	-0.75	(-0.15)
Q	20	QFP	5.07	(2.78)	-0.91	(-0.24)	2.66	(1.04)	2.25	(0.52)	6.44	(2.96)	-3.57	(-0.55)	3.14	(1.30)	2.43	(0.64)	0.09	(0.03)	3.43	(0.69)	6.47	(2.18)	2.89	(0.47)
Q	20	AFP	4.95	(2.78)	-0.75	(-0.22)	0.78	(0.36)	4.83	(1.30)	7.04	(3.13)	-4.39	(-0.89)	1.89	(0.81)	3.90	(1.10)	-0.41	(-0.15)	4.04	(1.23)	6.20	(1.94)	3.25	(0.67)
Q	20	QRB	5.23	(3.16)	-1.55	(-0.50)	3.42	(1.49)	1.29	(0.45)	8.37	(3.92)	-6.48	(-0.96)	3.01	(1.57)	2.28	(0.92)	0.81	(0.32)	2.36	(0.85)	6.84	(2.45)	2.14	(0.45)
A	10	AFP	4.86	(2.42)	-0.11	(-0.03)	1.10	(0.39)	4.86	(0.99)	7.14	(3.92)	-3.73	(-0.58)	5.02	(1.61)	0.56	(0.13)	-2.36	(-0.68)	6.87	(1.32)	12.65	(2.90)	-4.78	(-0.70)
A	16	AFP	4.50	(2.26)	0.38	(0.09)	0.87	(0.32)	5.16	(1.07)	6.75	(3.45)	-3.27	(-0.52)	4.93	(1.95)	0.53	(0.13)	-0.67	(-0.21)	4.97	(1.01)	9.54	(2.64)	-1.68	(-0.26)
A	20	AFP	5.21	(2.52)	-0.58	(-0.14)	0.71	(0.27)	5.36	(1.14)	7.28	(3.35)	-4.02	(-0.66)	2.45	(1.01)	3.61	(0.94)	-1.34	(-0.43)	5.58	(1.15)	6.56	(1.73)	3.03	(0.48)
		Min	4.49	(2.55)	-3.55	(-1.03)	0.63	(0.30)	-0.52	(-0.12)	6.44	(2.96)	-8.78	(-1.52)	1.16	(0.60)	0.06	(0.02)	-2.36	(-0.68)	1.22	(0.34)	5.78	(2.04)	-4.98	(-1.02)
		Max.	6.53	(3.61)	0.38	(0.09)	4.94	(1.91)	5.36	(1.14)	9.30	(4.39)	-3.27	(-0.52)	5.02	(1.61)	3.90	(1.10)	1.90	(0.60)	6.87	(1.32)	12.65	(2.90)	3.25	(0.67)
		Avg.	5.18	(2.97)	-1.30	(-0.39)	2.07	(0.87)	3.02	(0.75)	7.72	(3.65)	-5.65	(-1.01)	3.59	(1.49)	1.60	(0.47)	-0.23	(-0.08)	3.78	(0.92)	8.51	(2.65)	-0.42	(-0.06)

Table 9: Results for cross-sectional FM regressions with three independent variables for one-dimensional sorted Dimson beta portfolios.

See Table 8 for a description. This table presents FM regression results (intercepts–alphas and slopes on characteristics) full period beta for portfolios sorted by Dimson beta (10, 16, 20) using various beta estimates, size, and book-to-market as independent variables.

Panel A: FM results for equal-weight portfolios sorted on Dimsion beta.

			7/1960-10/2007								7/1960-6/1990								7/1990-10/2007							
Specification			Intercept		Beta		Size		B/M		Intercept		Beta		Size		B/M		Intercept		Beta		Size		B/M	
M	firms	MFP10	3.93	(1.54)	-3.04	(-0.96)	0.53	(1.45)	2.90	(3.90)	6.71	(2.18)	2.98	(0.77)	-0.76	(-1.73)	2.72	(2.59)	-5.17	(-1.22)	-9.20	(-1.80)	2.74	(4.47)	3.04	(3.33)
M	firms	MFP16	3.80	(1.48)	-2.93	(-0.93)	0.54	(1.47)	2.90	(3.90)	6.64	(2.14)	3.06	(0.78)	-0.75	(-1.69)	2.75	(2.64)	-5.47	(-1.28)	-8.92	(-1.75)	2.73	(4.46)	2.96	(3.22)
M	firms	MFP20	3.81	(1.48)	-2.87	(-0.91)	0.53	(1.45)	2.87	(3.87)	6.88	(2.27)	2.86	(0.75)	-0.76	(-1.71)	2.77	(2.67)	-5.52	(-1.29)	-8.73	(-1.70)	2.73	(4.43)	2.92	(3.18)
Q	firms	QFP10	2.78	(1.00)	-1.40	(-0.42)	0.56	(1.38)	3.10	(3.54)	7.08	(2.30)	3.03	(0.80)	-0.76	(-1.67)	3.05	(2.48)	-7.88	(-1.60)	-6.15	(-1.04)	2.81	(3.98)	2.98	(2.63)
Q	firms	QFP16	2.38	(0.85)	-0.71	(-0.22)	0.54	(1.33)	3.07	(3.53)	6.39	(2.04)	4.12	(1.05)	-0.79	(-1.73)	3.10	(2.56)	-8.51	(-1.72)	-4.97	(-0.87)	2.77	(3.89)	2.81	(2.46)
Q	firms	QFP20	2.40	(0.86)	-0.80	(-0.24)	0.55	(1.34)	3.05	(3.48)	6.83	(2.22)	3.46	(0.90)	-0.78	(-1.70)	3.07	(2.52)	-8.72	(-1.76)	-4.66	(-0.81)	2.77	(3.91)	2.79	(2.40)
M	10	MFP	3.05	(0.64)	-0.89	(-0.25)	0.32	(0.48)	3.18	(1.34)	1.36	(0.30)	4.55	(0.99)	-0.23	(-0.31)	1.27	(0.47)	5.85	(0.58)	-6.38	(-1.14)	0.53	(0.43)	6.55	(1.44)
M	10	AFP	3.25	(0.69)	0.76	(0.25)	-0.11	(-0.15)	1.54	(0.67)	5.63	(1.24)	6.62	(1.45)	-1.23	(-1.41)	1.72	(0.64)	-0.18	(-0.02)	-5.87	(-1.45)	0.97	(0.79)	3.05	(0.67)
M	10	MRB	5.52	(1.19)	-2.62	(-0.71)	0.01	(0.02)	2.65	(1.13)	4.46	(0.99)	-0.77	(-0.17)	0.03	(0.04)	1.84	(0.70)	7.36	(0.74)	-5.81	(-0.97)	-0.01	(-0.01)	4.06	(0.90)
M	16	MFP	8.45	(2.41)	-2.06	(-0.60)	-0.25	(-0.50)	4.00	(2.37)	6.33	(1.85)	1.11	(0.26)	-0.35	(-0.60)	3.67	(2.00)	9.37	(1.27)	-5.07	(-0.93)	-0.23	(-0.24)	3.59	(1.06)
M	16	AFP	7.22	(2.02)	-0.44	(-0.15)	-0.33	(-0.66)	2.94	(1.69)	5.49	(1.64)	4.41	(1.23)	-0.62	(-1.06)	3.39	(1.78)	8.54	(1.12)	-4.36	(-1.04)	-0.21	(-0.22)	3.25	(0.93)
M	16	MRB	5.95	(1.68)	-1.46	(-0.47)	-0.24	(-0.48)	2.26	(1.30)	6.09	(1.74)	1.59	(0.44)	-0.45	(-0.82)	2.90	(1.50)	5.70	(0.75)	-6.74	(-1.18)	0.14	(0.14)	1.16	(0.34)
M	20	MFP	4.85	(1.51)	-1.94	(-0.56)	0.18	(0.39)	2.46	(1.54)	4.94	(1.38)	2.46	(0.60)	-0.30	(-0.54)	2.16	(1.24)	2.46	(0.40)	-6.26	(-1.10)	0.74	(0.93)	2.85	(0.94)
M	20	AFP	4.22	(1.33)	-1.47	(-0.49)	0.19	(0.43)	2.21	(1.38)	3.61	(1.05)	5.91	(1.63)	-0.55	(-0.99)	1.65	(0.92)	0.23	(0.04)	-6.95	(-1.69)	1.09	(1.39)	3.13	(0.99)
M	20	MRB	3.95	(1.26)	-1.65	(-0.53)	0.12	(0.28)	1.60	(1.01)	4.27	(1.20)	1.88	(0.52)	-0.09	(-0.16)	1.79	(1.01)	3.39	(0.57)	-7.75	(-1.34)	0.49	(0.64)	1.28	(0.42)
Q	10	QFP	3.09	(0.69)	-0.28	(-0.07)	0.33	(0.48)	3.51	(1.50)	2.60	(0.61)	5.25	(1.13)	-0.52	(-0.65)	1.40	(0.58)	4.37	(0.48)	-5.44	(-0.74)	0.76	(0.64)	7.22	(1.44)
Q	10	AFP	2.77	(0.62)	1.42	(0.42)	-0.04	(-0.06)	1.87	(0.79)	5.74	(1.34)	6.88	(1.65)	-1.21	(-1.50)	2.01	(0.81)	-1.37	(-0.15)	-4.65	(-0.92)	1.07	(0.95)	3.27	(0.63)
Q	10	QRB	5.09	(1.14)	-0.36	(-0.11)	-0.01	(-0.02)	4.19	(1.73)	2.90	(0.66)	1.65	(0.51)	0.18	(0.24)	3.92	(1.63)	8.90	(0.93)	-3.86	(-0.52)	-0.35	(-0.27)	4.65	(0.90)
Q	16	QFP	8.81	(2.51)	-0.97	(-0.25)	-0.37	(-0.80)	4.00	(2.31)	7.04	(2.11)	1.57	(0.35)	-0.56	(-1.12)	3.33	(1.89)	9.72	(1.26)	-3.17	(-0.46)	-0.36	(-0.38)	3.86	(1.03)
Q	16	AFP	6.58	(1.80)	0.28	(0.09)	-0.29	(-0.62)	3.01	(1.74)	5.78	(1.83)	4.55	(1.31)	-0.64	(-1.26)	3.45	(1.91)	6.92	(0.85)	-2.96	(-0.56)	-0.10	(-0.11)	3.28	(0.87)
Q	16	QRB	7.73	(2.08)	0.31	(0.10)	-0.54	(-1.12)	3.24	(1.77)	6.42	(1.81)	3.36	(1.25)	-0.56	(-1.12)	4.06	(2.21)	10.00	(1.23)	-4.99	(-0.73)	-0.49	(-0.49)	1.82	(0.47)
Q	20	QFP	5.12	(1.44)	-0.67	(-0.17)	0.08	(0.17)	2.76	(1.58)	5.23	(1.40)	2.71	(0.62)	-0.41	(-0.77)	1.87	(1.03)	3.40	(0.48)	-3.33	(-0.48)	0.46	(0.53)	3.45	(0.97)
Q	20	AFP	3.63	(1.04)	-0.87	(-0.26)	0.24	(0.53)	2.36	(1.39)	3.95	(1.09)	6.02	(1.73)	-0.57	(-1.01)	1.80	(1.02)	-1.34	(-0.19)	-5.79	(-1.17)	1.22	(1.45)	3.30	(0.91)
Q	20	QRB	5.54	(1.61)	-0.75	(-0.25)	0.02	(0.04)	3.21	(1.81)	4.62	(1.22)	1.87	(0.72)	0.04	(0.07)	3.38	(1.78)	7.13	(1.05)	-5.29	(-0.77)	-0.01	(-0.01)	2.91	(0.82)
A	10	AFP	4.32	(0.92)	2.31	(0.56)	-0.34	(-0.47)	1.68	(0.72)	6.92	(1.36)	8.08	(1.48)	-1.48	(-1.73)	2.46	(0.85)	1.76	(0.19)	-3.48	(-0.55)	0.53	(0.51)	2.41	(0.53)
A	16	AFP	7.56	(1.69)	0.62	(0.17)	-0.41	(-0.73)	3.44	(1.83)	6.92	(1.76)	5.38	(1.20)	-0.84	(-1.44)	3.94	(1.96)	7.73	(0.75)	-2.32	(-0.39)	-0.23	(-0.19)	3.63	(0.99)
A	20	AFP	4.66	(1.11)	-0.86	(-0.22)	0.16	(0.32)	2.83	(1.55)	4.81	(1.08)	6.67	(1.56)	-0.72	(-1.25)	2.25	(1.19)	-0.44	(-0.05)	-5.51	(-0.88)	1.14	(1.16)	3.71	(0.94)
		Min.	2.77	(0.62)	-2.62	(-0.71)	-0.54	(-1.12)	1.54	(0.67)	1.36	(0.30)	-0.77	(-0.17)	-1.48	(-1.73)	1.27	(0.47)	-1.37	(-0.15)	-7.75	(-1.34)	-0.49	(-0.49)	1.16	(0.34)
		Max.	8.81	(2.51)	2.31	(0.56)	0.33	(0.48)	4.19	(1.73)	7.04	(2.11)	8.08	(1.48)	0.18	(0.24)	4.06	(2.21)	10.00	(1.23)	-2.32	(-0.39)	1.22	(1.45)	7.22	(1.44)
		Avg.	5.30	(1.40)	-0.55	(-0.17)	-0.06	(-0.12)	2.81	(1.48)	5.00	(1.32)	3.89	(0.97)	-0.53	(-0.83)	2.58	(1.29)	4.74	(0.58)	-5.05	(-0.91)	0.34	(0.36)	3.45	(0.87)

Table 9, Panel B: FM result for value-weight portfolios sorted on Dimson beta.

			7/1960-10/2007								7/1960-6/1990								7/1990-10/2007							
Specification			Intercept		Beta		Size		B/M		Intercept		Beta		Size		B/M		Intercept		Beta		Size		B/M	
M	firms	MFP10	4.35	(1.72)	-3.24	(-1.13)	0.55	(1.49)	3.02	(4.04)	6.89	(2.25)	2.42	(0.71)	-0.73	(-1.64)	2.80	(2.65)	-4.64	(-1.13)	-8.48	(-1.92)	2.73	(4.46)	3.34	(3.69)
M	firms	MFP16	4.13	(1.65)	-3.03	(-1.11)	0.56	(1.51)	3.04	(4.09)	6.88	(2.22)	2.45	(0.70)	-0.72	(-1.62)	2.81	(2.69)	-5.16	(-1.26)	-7.70	(-1.86)	2.70	(4.40)	3.32	(3.65)
M	firms	MFP20	3.84	(1.50)	-2.58	(-0.91)	0.54	(1.47)	3.02	(4.05)	6.80	(2.13)	2.65	(0.72)	-0.72	(-1.62)	2.90	(2.77)	-6.21	(-1.51)	-6.00	(-1.49)	2.65	(4.30)	3.08	(3.35)
Q	firms	QFP10	3.00	(1.10)	-1.37	(-0.47)	0.56	(1.38)	3.20	(3.66)	7.06	(2.27)	2.78	(0.80)	-0.74	(-1.63)	3.11	(2.54)	-7.35	(-1.54)	-5.34	(-1.17)	2.79	(3.93)	3.15	(2.84)
Q	firms	QFP16	2.65	(0.97)	-0.96	(-0.35)	0.56	(1.38)	3.21	(3.70)	6.82	(2.18)	3.12	(0.88)	-0.75	(-1.64)	3.18	(2.64)	-8.02	(-1.69)	-4.47	(-1.03)	2.77	(3.90)	3.03	(2.70)
Q	firms	QFP20	2.68	(0.97)	-0.92	(-0.32)	0.55	(1.34)	3.18	(3.65)	7.08	(2.23)	2.83	(0.78)	-0.74	(-1.62)	3.23	(2.67)	-8.23	(-1.72)	-3.90	(-0.89)	2.73	(3.84)	2.95	(2.58)
M	10	MFP	-5.37	(-0.85)	4.77	(1.25)	0.86	(1.15)	2.00	(0.68)	1.46	(0.26)	6.65	(1.50)	0.01	(0.01)	6.93	(1.95)	-14.55	(-1.05)	-2.30	(-0.30)	2.53	(1.66)	-3.32	(-0.64)
M	10	AFP	-2.93	(-0.46)	4.76	(1.16)	0.56	(0.71)	2.94	(1.03)	3.95	(0.71)	11.23	(2.72)	-1.21	(-1.35)	4.65	(1.29)	-0.96	(-0.07)	-6.47	(-1.66)	1.70	(1.17)	0.73	(0.16)
M	10	MRB	-7.11	(-1.12)	5.39	(1.46)	0.78	(1.01)	0.60	(0.21)	1.89	(0.33)	6.10	(1.48)	-0.15	(-0.18)	5.87	(1.69)	-22.69	(-1.60)	4.15	(0.58)	2.38	(1.52)	-8.51	(-1.64)
M	16	MFP	0.14	(0.03)	2.95	(0.82)	0.26	(0.42)	2.38	(1.16)	6.11	(1.29)	4.85	(1.11)	-0.67	(-1.07)	5.85	(2.59)	-11.30	(-0.96)	1.50	(0.24)	1.69	(1.29)	-4.09	(-0.98)
M	16	AFP	2.24	(0.41)	2.08	(0.62)	0.23	(0.38)	3.52	(1.69)	6.24	(1.39)	5.06	(1.56)	-0.69	(-1.07)	5.52	(2.35)	-4.59	(-0.38)	-1.71	(-0.42)	1.49	(1.16)	-1.44	(-0.34)
M	16	MRB	-1.19	(-0.23)	3.62	(1.13)	0.16	(0.26)	0.54	(0.25)	5.93	(1.27)	4.55	(1.25)	-0.74	(-1.24)	4.36	(1.80)	-13.52	(-1.15)	2.00	(0.33)	1.72	(1.30)	-6.09	(-1.49)
M	20	MFP	0.00	(0.00)	4.00	(1.13)	0.25	(0.44)	2.02	(1.07)	2.95	(0.68)	5.28	(1.26)	-0.37	(-0.61)	4.53	(2.03)	-4.92	(-0.50)	2.68	(0.46)	1.16	(1.04)	-2.13	(-0.62)
M	20	AFP	1.13	(0.24)	5.08	(1.72)	0.03	(0.05)	1.83	(0.99)	3.45	(0.84)	4.70	(1.62)	-0.36	(-0.59)	4.39	(1.98)	0.14	(0.01)	2.00	(0.58)	0.75	(0.65)	-1.37	(-0.39)
M	20	MRB	-0.10	(-0.02)	4.67	(1.59)	0.09	(0.17)	1.11	(0.59)	2.52	(0.57)	5.46	(1.51)	-0.46	(-0.79)	3.20	(1.40)	-4.63	(-0.49)	3.29	(0.66)	1.05	(0.99)	-2.51	(-0.78)
Q	10	QFP	-4.62	(-0.67)	7.06	(1.64)	0.52	(0.66)	1.35	(0.44)	1.50	(0.28)	9.12	(1.83)	-0.33	(-0.43)	6.70	(2.01)	-13.24	(-0.80)	0.90	(0.09)	2.11	(1.06)	-3.64	(-0.58)
Q	10	AFP	-4.51	(-0.66)	5.38	(1.19)	0.70	(0.85)	2.81	(0.98)	3.56	(0.70)	11.77	(2.94)	-1.19	(-1.46)	4.59	(1.37)	-4.47	(-0.31)	-5.85	(-1.23)	2.04	(1.26)	0.55	(0.11)
Q	10	QRB	-3.92	(-0.55)	6.77	(2.02)	0.41	(0.44)	0.92	(0.29)	2.33	(0.44)	5.77	(1.65)	0.08	(0.10)	7.55	(2.29)	-14.79	(-0.86)	8.51	(1.23)	0.99	(0.46)	-10.60	(-1.63)
Q	16	QFP	1.21	(0.20)	4.31	(1.12)	0.04	(0.06)	2.41	(1.03)	7.00	(1.45)	5.06	(0.95)	-0.85	(-1.41)	5.49	(2.12)	-9.35	(-0.66)	4.15	(0.63)	1.25	(0.80)	-5.03	(-1.10)
Q	16	AFP	0.76	(0.13)	2.78	(0.76)	0.34	(0.50)	3.52	(1.52)	6.64	(1.51)	5.54	(1.57)	-0.75	(-1.25)	5.77	(2.24)	-8.75	(-0.64)	-0.90	(-0.20)	1.87	(1.23)	-1.85	(-0.42)
Q	16	QRB	2.74	(0.46)	3.86	(1.43)	-0.04	(-0.06)	2.64	(1.07)	8.60	(1.94)	4.68	(1.67)	-0.76	(-1.26)	7.45	(2.80)	-7.46	(-0.53)	2.44	(0.43)	1.21	(0.68)	-5.72	(-1.19)
Q	20	QFP	0.46	(0.09)	5.36	(1.38)	0.07	(0.11)	1.74	(0.81)	2.65	(0.64)	6.77	(1.40)	-0.49	(-0.85)	4.61	(1.85)	-3.92	(-0.32)	4.99	(0.76)	0.86	(0.63)	-2.98	(-0.77)
Q	20	AFP	-0.27	(-0.05)	5.74	(1.81)	0.13	(0.21)	1.76	(0.87)	3.85	(1.01)	5.05	(1.64)	-0.42	(-0.74)	4.63	(1.89)	-3.97	(-0.32)	2.97	(0.73)	1.11	(0.81)	-1.92	(-0.53)
Q	20	QRB	1.96	(0.35)	4.59	(1.77)	-0.06	(-0.08)	0.95	(0.42)	4.87	(1.20)	3.74	(1.35)	-0.32	(-0.56)	4.96	(2.03)	-3.10	(-0.23)	6.06	(1.16)	0.41	(0.25)	-6.03	(-1.39)
A	10	AFP	-4.91	(-0.62)	6.18	(1.18)	0.68	(0.76)	1.92	(0.52)	2.88	(0.39)	13.15	(2.44)	-1.21	(-1.14)	4.33	(1.40)	-1.43	(-0.10)	-5.47	(-0.77)	1.53	(1.40)	-1.41	(-0.19)
A	16	AFP	1.93	(0.23)	2.82	(0.72)	0.28	(0.34)	3.84	(1.22)	6.74	(1.08)	7.09	(1.56)	-0.83	(-1.04)	6.31	(2.41)	-4.71	(-0.26)	-1.37	(-0.23)	1.47	(0.92)	-1.89	(-0.28)
A	20	AFP	1.30	(0.18)	6.31	(1.77)	-0.04	(-0.06)	1.96	(0.72)	3.10	(0.59)	6.86	(1.54)	-0.44	(-0.70)	5.02	(2.13)	1.45	(0.08)	3.36	(0.58)	0.54	(0.34)	-1.70	(-0.27)
		Min.	-7.11	(-1.12)	2.08	(0.62)	-0.06	(-0.08)	0.54	(0.25)	1.46	(0.26)	3.74	(1.35)	-1.21	(-1.35)	3.20	(1.40)	-22.69	(-1.60)	-6.47	(-1.66)	0.41	(0.25)	-10.60	(-1.63)
		Max.	2.74	(0.46)	7.06	(1.64)	0.86	(1.15)	3.84	(1.22)	8.60	(1.94)	13.15	(2.44)	0.08	(0.10)	7.55	(2.29)	1.45	(0.08)	8.51	(1.23)	2.53	(1.66)	0.73	(0.16)
		Avg.	-1.00	(-0.14)	4.69	(1.32)	0.30	(0.40)	2.04	(0.84)	4.20	(0.88)	6.59	(1.65)	-0.58	(-0.84)	5.37	(1.98)	-7.18	(-0.53)	1.19	(0.17)	1.42	(0.98)	-3.38	(-0.71)

Table 10: Results for cross-sectional FM regressions for two-dimensional sorted portfolios by size and book-to-market.

See Table 8 for a description. This table presents FM regression results for two-dimensional sorted portfolios, first by size, then by book-to market.

Panel A: FM results for equal-weight portfolios, sorted first by size, then by book-to-market.

			7/1960-10/2007								7/1960-6/1990								7/1990-10/2007							
Specification			Intercept		Beta		Size		B/M		Intercept		Beta		Size		B/M		Intercept		Beta		Size		B/M	
M	firms	MFP16	2.67	(0.82)	-1.27	(-0.24)	0.63	(1.38)	3.34	(3.98)	9.88	(2.42)	-1.74	(-0.27)	-0.52	(-0.95)	3.44	(3.00)	-10.81	(-2.18)	1.54	(0.20)	2.41	(3.39)	2.78	(2.48)
M	firms	MFP25	1.50	(0.49)	0.72	(0.14)	0.51	(1.14)	3.20	(3.87)	8.35	(2.29)	0.68	(0.13)	-0.65	(-1.32)	3.30	(2.88)	-7.66	(-1.56)	-6.80	(-0.91)	2.88	(4.00)	3.30	(2.94)
M	firms	MFP36	4.97	(1.69)	-6.25	(-1.30)	0.92	(2.08)	3.59	(4.49)	12.66	(3.75)	-6.80	(-1.44)	-0.18	(-0.38)	3.73	(3.29)	-8.13	(-1.82)	-5.29	(-0.78)	2.77	(3.98)	3.14	(3.17)
Q	firms	MFP16	5.54	(1.75)	-9.41	(-1.95)	1.26	(2.58)	4.12	(4.75)	9.61	(2.36)	-0.19	(-0.03)	-0.59	(-1.07)	3.80	(3.01)	-9.42	(-1.80)	-7.39	(-1.11)	3.16	(4.09)	3.01	(2.67)
Q	firms	MFP25	2.73	(0.86)	-3.26	(-0.66)	0.82	(1.64)	3.52	(4.05)	8.69	(2.28)	0.99	(0.19)	-0.68	(-1.32)	3.63	(2.86)	-7.41	(-1.36)	-16.64	(-2.53)	3.84	(5.25)	3.56	(3.12)
Q	firms	MFP36	3.60	(1.25)	-5.47	(-1.17)	0.98	(1.88)	3.59	(4.42)	10.43	(3.05)	-1.60	(-0.33)	-0.48	(-0.89)	3.88	(3.09)	-9.01	(-1.74)	-10.07	(-1.60)	3.38	(4.33)	2.99	(2.75)
M	3*3	MFP	11.55	(1.87)	-19.85	(-1.61)	1.77	(2.25)	5.04	(3.46)	13.25	(2.27)	-8.44	(-0.82)	-0.07	(-0.10)	4.03	(2.81)	-9.29	(-1.39)	-2.36	(-0.17)	2.50	(2.75)	3.05	(1.47)
M	3*3	AFP	1.23	(0.20)	2.32	(0.18)	0.36	(0.43)	2.79	(1.62)	7.86	(1.57)	2.61	(0.26)	-0.84	(-0.99)	3.13	(1.79)	-8.17	(-1.52)	-2.63	(-0.37)	2.34	(3.80)	2.81	(1.74)
M	3*3	MRB	-2.05	(-0.55)	3.90	(0.69)	0.29	(0.65)	1.63	(1.26)	2.30	(0.50)	9.10	(1.36)	-0.89	(-1.63)	1.13	(0.67)	-9.59	(-1.49)	-5.10	(-0.51)	2.33	(3.06)	2.51	(1.23)
M	4*4	MFP	6.47	(1.63)	-10.70	(-1.44)	1.28	(2.30)	4.54	(4.22)	10.47	(2.20)	-4.12	(-0.51)	-0.27	(-0.42)	4.06	(3.15)	-7.38	(-1.34)	-9.50	(-0.91)	3.06	(3.74)	4.32	(2.45)
M	4*4	AFP	4.81	(1.32)	-7.80	(-1.19)	1.12	(2.07)	4.48	(3.80)	8.02	(2.20)	0.90	(0.14)	-0.59	(-0.93)	3.79	(2.52)	-6.42	(-1.28)	-8.33	(-1.62)	2.77	(4.37)	3.86	(2.69)
M	4*4	MRB	-2.22	(-0.81)	1.97	(0.53)	0.60	(1.55)	2.64	(2.83)	4.35	(1.31)	6.09	(1.38)	-0.77	(-1.64)	2.67	(2.25)	-13.60	(-2.92)	-5.18	(-0.77)	2.99	(4.62)	2.58	(1.70)
M	5*5	MFP	0.61	(0.18)	1.92	(0.31)	0.45	(0.93)	3.35	(3.47)	7.30	(1.89)	2.84	(0.49)	-0.80	(-1.60)	3.55	(2.88)	-6.00	(-1.17)	-13.14	(-1.47)	3.31	(4.42)	4.29	(2.88)
M	5*5	AFP	0.88	(0.27)	1.79	(0.34)	0.42	(0.88)	3.28	(3.30)	6.23	(1.94)	6.82	(1.43)	-1.19	(-2.15)	2.95	(2.18)	-5.76	(-1.19)	-8.63	(-2.04)	2.70	(4.36)	3.23	(2.51)
M	5*5	MRB	-2.30	(-0.91)	2.62	(0.80)	0.48	(1.30)	2.20	(2.51)	3.45	(1.10)	7.42	(1.93)	-0.93	(-2.09)	2.26	(1.89)	-12.26	(-2.95)	-5.68	(-0.96)	2.91	(4.76)	2.11	(1.72)
M	6*6	MFP	4.54	(1.39)	-4.88	(-0.87)	0.76	(1.64)	3.91	(4.17)	11.55	(3.11)	-4.02	(-0.74)	-0.44	(-0.87)	3.92	(3.07)	-6.88	(-1.52)	-8.10	(-1.07)	2.90	(4.22)	3.93	(3.15)
M	6*6	AFP	2.75	(1.02)	-0.23	(-0.06)	0.42	(0.99)	3.55	(3.97)	8.92	(2.92)	1.66	(0.47)	-0.82	(-1.60)	3.62	(2.80)	-6.77	(-1.59)	-5.85	(-1.63)	2.60	(4.20)	3.27	(2.73)
M	6*6	MRB	-0.27	(-0.11)	-0.01	(0.00)	0.50	(1.32)	2.66	(3.01)	5.90	(1.99)	5.24	(1.55)	-0.98	(-2.12)	2.68	(2.23)	-10.95	(-2.64)	-9.09	(-1.50)	3.07	(4.89)	2.61	(2.14)
Q	3*3	QFP	6.99	(1.02)	-11.29	(-0.72)	1.50	(1.41)	5.00	(2.56)	11.21	(1.73)	-4.18	(-0.40)	-0.29	(-0.43)	4.13	(2.32)	-10.90	(-1.86)	4.40	(0.35)	2.08	(2.26)	2.66	(1.50)
Q	3*3	AFP	1.13	(0.19)	2.87	(0.23)	0.38	(0.46)	3.02	(1.74)	8.23	(1.64)	2.61	(0.30)	-0.83	(-1.24)	3.33	(1.96)	-8.66	(-1.52)	-1.98	(-0.30)	2.41	(3.63)	3.20	(1.97)
Q	3*3	QRB	4.29	(1.11)	-2.79	(-0.54)	0.67	(1.43)	4.23	(3.49)	9.20	(1.86)	-1.97	(-0.32)	-0.39	(-0.66)	3.88	(2.43)	-4.25	(-0.70)	-4.21	(-0.44)	2.50	(3.43)	4.84	(2.64)
Q	4*4	QFP	6.22	(1.58)	-10.32	(-1.31)	1.43	(2.29)	5.20	(4.49)	8.93	(1.85)	-0.06	(-0.01)	-0.49	(-0.75)	4.11	(2.80)	-9.81	(-1.77)	-2.26	(-0.26)	2.66	(3.79)	3.77	(2.32)
Q	4*4	AFP	5.01	(1.31)	-8.06	(-1.28)	1.19	(2.15)	4.79	(4.00)	8.42	(2.24)	0.98	(0.16)	-0.59	(-0.98)	3.97	(2.56)	-6.94	(-1.20)	-7.89	(-1.50)	2.86	(4.18)	4.25	(2.63)
Q	4*4	QRB	-0.96	(-0.31)	2.65	(0.90)	0.51	(1.20)	3.21	(3.06)	5.89	(1.65)	5.19	(1.47)	-0.79	(-1.56)	3.31	(2.38)	-12.88	(-2.38)	-1.76	(-0.34)	2.75	(4.11)	3.04	(1.94)
Q	5*5	QFP	1.17	(0.35)	2.21	(0.35)	0.41	(0.74)	3.53	(3.47)	5.80	(1.52)	6.97	(1.22)	-1.11	(-2.27)	3.28	(2.29)	-7.84	(-1.43)	-12.26	(-1.52)	3.51	(5.13)	4.45	(3.24)
Q	5*5	AFP	0.75	(0.21)	2.25	(0.42)	0.44	(0.91)	3.53	(3.32)	6.40	(1.98)	7.41	(1.74)	-1.24	(-2.39)	3.10	(2.18)	-6.20	(-1.05)	-8.36	(-1.89)	2.79	(4.26)	3.64	(2.55)
Q	5*5	QRB	0.43	(0.14)	1.71	(0.76)	0.49	(1.25)	3.57	(3.51)	6.61	(1.94)	4.68	(1.69)	-0.86	(-1.92)	3.67	(2.64)	-10.34	(-1.92)	-3.45	(-0.91)	2.85	(4.31)	3.39	(2.43)
Q	6*6	QFP	3.07	(0.97)	-1.12	(-0.18)	0.57	(1.06)	3.89	(4.10)	9.99	(2.80)	0.00	(0.00)	-0.65	(-1.24)	3.88	(2.70)	-9.01	(-1.75)	-3.27	(-0.43)	2.74	(4.03)	3.63	(2.88)
Q	6*6	AFP	2.45	(0.79)	0.42	(0.11)	0.44	(1.01)	3.80	(3.86)	9.12	(2.67)	1.95	(0.54)	-0.83	(-1.66)	3.81	(2.66)	-7.48	(-1.46)	-5.24	(-1.22)	2.70	(4.09)	3.64	(2.79)
Q	6*6	QRB	2.15	(0.74)	0.04	(0.02)	0.46	(1.09)	3.54	(3.56)	9.21	(2.80)	1.80	(0.78)	-0.85	(-1.69)	3.64	(2.64)	-10.13	(-1.97)	-3.02	(-0.90)	2.74	(4.01)	3.37	(2.56)
A	4*4	AFP	5.73	(1.30)	-7.70	(-1.14)	1.12	(1.87)	5.06	(3.67)	9.03	(1.87)	1.37	(0.19)	-0.64	(-0.90)	4.31	(2.37)	-5.85	(-0.79)	-8.45	(-1.06)	2.84	(6.47)	4.49	(1.86)
A	5*5	AFP	1.03	(0.26)	4.08	(0.69)	0.28	(0.48)	3.65	(3.15)	6.60	(1.65)	9.01	(1.62)	-1.39	(-2.05)	3.26	(2.24)	-5.77	(-0.89)	-6.97	(-0.97)	2.67	(5.14)	3.73	(1.82)
A	6*6	AFP	2.62	(0.72)	2.29	(0.43)	0.27	(0.50)	3.93	(3.42)	9.01	(2.25)	3.92	(0.84)	-1.00	(-1.58)	3.92	(2.74)	-7.04	(-1.31)	-3.74	(-0.52)	2.56	(5.15)	3.76	(1.95)
		Min.	-2.30	(-0.91)	-19.85	(-1.61)	0.27	(0.50)	1.63	(1.26)	2.30	(0.50)	-8.44	(-0.82)	-1.39	(-2.05)	1.13	(0.67)	-13.60	(-2.92)	-13.14	(-1.47)	2.08	(2.26)	2.11	(1.72)
		Max.	11.55	(1.87)	4.08	(0.69)	1.77	(2.25)	5.20	(4.49)	13.25	(2.27)	9.10	(1.36)	-0.07	(-0.10)	4.31	(2.37)	-4.25	(-0.70)	4.40	(0.35)	3.51	(5.13)	4.84	(2.64)
		Avg.	2.52	(0.59)	-1.91	(-0.13)	0.69	(1.27)	3.70	(3.30)	7.90	(1.98)	2.44	(0.62)	-0.76	(-1.39)	3.46	(2.41)	-8.38	(-1.59)	-5.63	(-0.92)	2.75	(4.19)	3.50	(2.28)

Table 10, Panel B: FM results for value-weight portfolios, sorted first by size, then by book-to-market.

			7/1960-10/2007								7/1960-6/1990								7/1990-10/2007							
Specification			Intercept		Beta		Size		B/M		Intercept		Beta		Size		B/M		Intercept		Beta		Size		B/M	
M	firms	MFP16	3.16	(1.22)	-2.75	(-0.83)	0.76	(1.76)	3.34	(4.15)	11.30	(3.56)	-4.71	(-1.13)	-0.28	(-0.54)	3.48	(3.14)	-9.74	(-2.25)	-1.66	(-0.34)	2.59	(3.65)	2.90	(2.71)
M	firms	MFP25	2.81	(1.10)	-2.58	(-0.74)	0.74	(1.69)	3.30	(4.13)	9.71	(3.18)	-1.93	(-0.51)	-0.46	(-0.96)	3.39	(3.07)	-7.38	(-1.66)	-11.04	(-1.92)	3.37	(4.50)	3.55	(3.17)
M	firms	MFP36	4.91	(1.92)	-7.20	(-2.03)	1.04	(2.43)	3.56	(4.49)	11.62	(3.76)	-5.26	(-1.30)	-0.25	(-0.51)	3.59	(3.21)	-7.66	(-1.79)	-8.77	(-1.69)	3.12	(4.50)	3.33	(3.31)
Q	firms	MFP16	4.02	(1.37)	-8.21	(-2.72)	1.37	(2.98)	3.91	(4.44)	11.98	(3.19)	-5.30	(-1.12)	-0.20	(-0.39)	4.13	(3.34)	-11.03	(-2.03)	-5.91	(-1.47)	3.28	(4.03)	2.90	(2.49)
Q	firms	MFP25	2.89	(0.97)	-5.23	(-1.54)	1.06	(2.22)	3.60	(4.09)	8.95	(2.53)	0.41	(0.10)	-0.64	(-1.29)	3.72	(3.00)	-9.89	(-1.82)	-13.91	(-2.99)	3.99	(5.32)	3.37	(2.81)
Q	firms	MFP36	4.09	(1.45)	-8.19	(-2.51)	1.28	(2.58)	3.75	(4.41)	10.37	(3.14)	-1.59	(-0.38)	-0.47	(-0.87)	3.85	(3.10)	-9.93	(-1.86)	-11.67	(-2.46)	3.71	(4.61)	3.00	(2.57)
M	3*3	MFP	3.77	(1.14)	-2.69	(-0.43)	0.60	(1.03)	2.83	(2.73)	9.19	(2.33)	-2.39	(-0.37)	-0.29	(-0.48)	3.09	(2.55)	-6.23	(-1.25)	-0.86	(-0.09)	1.76	(1.80)	1.91	(1.03)
M	3*3	AFP	4.00	(1.40)	-1.67	(-0.29)	0.46	(0.74)	2.79	(2.61)	8.25	(2.15)	0.72	(0.10)	-0.51	(-0.66)	2.98	(1.99)	-4.53	(-0.97)	-4.79	(-1.00)	1.95	(2.62)	1.81	(1.16)
M	3*3	MRB	1.82	(0.57)	-2.96	(-0.67)	0.68	(1.42)	2.26	(2.04)	7.21	(1.84)	3.05	(0.60)	-0.75	(-1.48)	2.58	(1.97)	-7.52	(-1.43)	-13.35	(-1.66)	3.16	(3.36)	1.71	(0.85)
M	4*4	MFP	3.62	(1.09)	-3.33	(-0.61)	0.75	(1.46)	3.70	(3.55)	9.38	(2.34)	-3.75	(-0.61)	-0.11	(-0.18)	3.66	(2.91)	-4.94	(-0.95)	-6.74	(-0.75)	2.34	(2.60)	3.73	(1.96)
M	4*4	AFP	5.09	(1.57)	-7.63	(-1.12)	1.06	(1.60)	4.13	(3.41)	7.92	(2.19)	-1.56	(-0.25)	-0.17	(-0.24)	3.81	(2.43)	-4.22	(-0.89)	-7.38	(-1.64)	2.29	(3.26)	3.27	(2.20)
M	4*4	MRB	-2.28	(-0.78)	2.64	(0.72)	0.48	(1.14)	2.03	(1.99)	2.77	(0.76)	7.67	(1.73)	-0.84	(-1.71)	1.77	(1.39)	-11.01	(-2.29)	-6.08	(-0.96)	2.77	(3.61)	2.49	(1.46)
M	5*5	MFP	0.29	(0.10)	5.20	(1.06)	0.08	(0.17)	3.11	(3.29)	7.42	(2.11)	2.76	(0.57)	-0.70	(-1.45)	3.91	(3.17)	-4.23	(-0.85)	-13.15	(-1.64)	2.96	(3.70)	3.56	(2.31)
M	5*5	AFP	2.53	(0.94)	1.07	(0.28)	0.26	(0.56)	3.22	(3.47)	5.23	(1.60)	10.49	(2.10)	-1.47	(-2.46)	2.81	(2.00)	-5.04	(-1.10)	-7.06	(-2.24)	2.36	(3.61)	2.46	(1.89)
M	5*5	MRB	-2.00	(-0.78)	2.43	(0.81)	0.48	(1.27)	1.94	(2.15)	4.12	(1.30)	5.93	(1.66)	-0.77	(-1.74)	2.49	(2.09)	-12.59	(-2.93)	-3.64	(-0.68)	2.65	(3.99)	0.99	(0.73)
M	6*6	MFP	2.93	(0.99)	-1.82	(-0.38)	0.59	(1.29)	3.20	(3.39)	7.92	(2.21)	0.33	(0.06)	-0.46	(-0.90)	3.35	(2.62)	-5.67	(-1.25)	-7.57	(-1.18)	2.55	(3.67)	3.05	(2.31)
M	6*6	AFP	1.41	(0.55)	3.74	(1.16)	0.10	(0.22)	2.68	(2.98)	6.68	(2.25)	4.22	(1.28)	-0.81	(-1.51)	2.97	(2.27)	-6.89	(-1.57)	-1.98	(-0.65)	2.11	(3.28)	2.24	(1.76)
M	6*6	MRB	-0.56	(-0.23)	0.61	(0.22)	0.54	(1.41)	2.25	(2.49)	4.96	(1.63)	4.95	(1.49)	-0.77	(-1.68)	2.37	(1.96)	-10.11	(-2.41)	-6.89	(-1.36)	2.82	(4.32)	2.05	(1.56)
Q	3*3	QFP	4.30	(1.20)	-4.08	(-0.53)	0.86	(1.16)	3.22	(2.71)	11.03	(2.24)	-5.71	(-0.69)	-0.02	(-0.02)	3.62	(2.49)	-5.96	(-1.02)	0.02	(0.00)	1.70	(1.45)	1.75	(1.01)
Q	3*3	AFP	3.62	(1.08)	-0.31	(-0.05)	0.43	(0.66)	2.90	(2.55)	8.64	(2.08)	0.75	(0.10)	-0.53	(-0.71)	3.11	(1.96)	-5.47	(-0.95)	-3.12	(-0.58)	1.98	(2.51)	2.05	(1.24)
Q	3*3	QRB	3.36	(0.94)	-4.32	(-0.95)	0.80	(1.51)	2.96	(2.51)	9.13	(1.97)	-0.95	(-0.17)	-0.41	(-0.72)	3.63	(2.40)	-6.68	(-1.22)	-10.18	(-1.27)	2.90	(2.89)	1.80	(0.96)
Q	4*4	QFP	3.52	(1.07)	-2.99	(-0.54)	0.83	(1.52)	3.98	(3.56)	10.07	(2.21)	-4.46	(-0.55)	-0.03	(-0.04)	3.97	(2.85)	-6.28	(-1.08)	-1.32	(-0.16)	2.00	(2.21)	3.34	(1.64)
Q	4*4	AFP	4.71	(1.35)	-6.39	(-0.93)	1.02	(1.52)	4.22	(3.37)	8.16	(2.34)	-1.08	(-0.17)	-0.23	(-0.32)	3.84	(2.43)	-5.08	(-0.87)	-6.09	(-1.17)	2.34	(3.14)	3.59	(2.06)
Q	4*4	QRB	1.19	(0.38)	0.01	(0.00)	0.56	(1.19)	3.33	(3.09)	6.87	(1.84)	3.90	(1.03)	-0.73	(-1.34)	3.24	(2.37)	-8.68	(-1.57)	-6.76	(-1.37)	2.79	(3.46)	3.49	(1.98)
Q	5*5	QFP	1.26	(0.42)	4.76	(0.93)	0.03	(0.05)	3.20	(3.10)	6.06	(1.66)	6.62	(1.23)	-1.02	(-2.16)	3.64	(2.55)	-6.00	(-1.07)	-13.44	(-1.81)	3.24	(4.15)	3.68	(2.43)
Q	5*5	AFP	2.18	(0.72)	1.98	(0.50)	0.26	(0.55)	3.40	(3.30)	5.33	(1.64)	11.28	(2.19)	-1.54	(-2.61)	2.87	(1.91)	-5.84	(-1.02)	-6.40	(-1.73)	2.48	(3.61)	2.85	(1.98)
Q	5*5	QRB	1.04	(0.35)	-0.86	(-0.39)	0.66	(1.69)	3.42	(3.28)	6.95	(2.00)	3.51	(1.37)	-0.69	(-1.63)	3.91	(2.79)	-9.23	(-1.68)	-8.46	(-2.12)	3.02	(4.29)	2.58	(1.70)
Q	6*6	QFP	3.29	(1.10)	-1.94	(-0.41)	0.64	(1.27)	3.45	(3.50)	7.65	(2.22)	2.42	(0.43)	-0.61	(-1.13)	3.28	(2.29)	-7.13	(-1.31)	-4.80	(-0.70)	2.51	(3.57)	2.85	(1.93)
Q	6*6	AFP	1.05	(0.36)	4.67	(1.40)	0.09	(0.20)	2.85	(2.89)	6.90	(2.09)	4.66	(1.33)	-0.85	(-1.63)	3.10	(2.14)	-7.64	(-1.43)	-1.45	(-0.39)	2.23	(3.22)	2.57	(1.79)
Q	6*6	QRB	2.06	(0.70)	-1.83	(-0.95)	0.66	(1.56)	3.24	(3.12)	8.20	(2.43)	0.98	(0.44)	-0.57	(-1.15)	3.46	(2.50)	-8.61	(-1.61)	-6.71	(-1.89)	2.80	(3.93)	2.85	(1.88)
A	4*4	AFP	6.16	(1.39)	-7.72	(-1.07)	1.06	(1.40)	4.66	(2.85)	8.70	(1.79)	-0.62	(-0.07)	-0.25	(-0.27)	4.20	(2.16)	-3.24	(-0.45)	-7.39	(-1.02)	2.28	(5.12)	3.86	(1.43)
A	5*5	AFP	3.18	(0.80)	2.80	(0.55)	0.11	(0.20)	3.65	(2.78)	5.66	(1.30)	13.11	(1.86)	-1.72	(-1.99)	3.11	(1.81)	-4.45	(-0.68)	-5.49	(-0.84)	2.26	(4.18)	2.91	(1.37)
A	6*6	AFP	1.60	(0.43)	5.97	(1.32)	-0.07	(-0.14)	2.99	(2.59)	6.77	(1.64)	6.69	(1.41)	-1.02	(-1.51)	3.20	(2.23)	-6.48	(-1.10)	-0.75	(-0.12)	2.07	(4.46)	2.68	(1.31)
		Min.	-2.28	(-0.78)	-7.72	(-1.07)	-0.07	(-0.14)	1.94	(2.15)	2.77	(0.76)	-5.71	(-0.69)	-1.72	(-1.99)	1.77	(1.39)	-12.59	(-2.93)	-13.44	(-1.81)	1.70	(1.45)	0.99	(0.73)
		Max.	6.16	(1.39)	5.97	(1.32)	1.06	(1.40)	4.66	(2.85)	11.03	(2.24)	13.11	(1.86)	-0.02	(-0.02)	4.20	(2.16)	-3.24	(-0.45)	0.02	(0.00)	3.24	(4.15)	3.86	(1.43)
		Avg.	2.34	(0.70)	-0.54	(-0.01)	0.52	(0.99)	3.17	(2.94)	7.30	(1.93)	2.72	(0.67)	-0.66	(-1.17)	3.26	(2.30)	-6.66	(-1.29)	-5.99	(-1.07)	2.46	(3.41)	2.67	(1.63)

PART IV

Important Characteristics, Weaknesses and Errors in German Equity Data from Thomson Reuters Datastream and their Implications for Empirical Studies on Stock Returns

Contents

Important Characteristics, Weaknesses and Errors in German Equity Data from Thomson Reuters Datastream and their Implications for Empirical Studies on Stock Returns

Abstract

We examine the characteristics and the quality of equity data from Thomson Reuters Datastream (Datastream) to evaluate whether Datastream can be used as the primary data source for academic studies on the German market. We document market coverage issues in Datastream before 1990. Additionally, Datastream's coverage of dividends is sufficient for standard academic use only from 1990 onwards; systematic data errors are rare after 1990. Existing errors in Datastream's total return index are mainly caused by price differences and incorrect adjustments for dividends and corporate actions. One of the important weaknesses documented is Datastream does not provide any information about the market segment in which a stock is listed. Consequently, the standard procedure of using portfolio breakpoints from the top market segment cannot be followed. Therefore, we show that this has important implications when studying the size effect in Germany. To conclude, we cannot recommend Datastream as the primary data source before 1990. Equity data for the time period after 1990 should be handled with care!

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1 Introduction

The quality of empirical research on a stock market depends on sufficient data quality. Rosenberg/Houglet (1974, p. 1303) argue that "[t]he presence of erroneous data can destroy a research effort and seriously damage the management decisions based upon research." Systematic data errors may arise because data, such as dividends and stock splits, are usually collected more carefully for large firms than for small firms. According to De Moor/Sercu (2012, p. 8) "[…] it is generally accepted [among empirical researchers] that the probability of data errors is negatively related to firm size, especially for the tiny, illiquid and penny stocks." One reason is that large firms are more important from an economic perspective. The largest 10% of all firms in a market usually represent 60-70% or more of the market capitalization. Given the high costs of collecting data for small firms in comparison with the low marginal benefits, incentives exist to primarily focus on large firms and to neglect small firms. As a result of omitted dividends and stock splits, returns are usually systematically underestimated. Hence, the observed performance of small firms might appear worse than their actual performance. The chance to find support for the well documented size anomaly of Banz (1981) decreases when returns of small stocks are systematically downward biased due to missing dividends.

Most recent empirical studies carefully screen the data, winsorize the data, or remove outliers to overcome data errors and/or to improve regression fits. An overwhelming part of the economic literature on the cross-section of stock returns does not address data quality directly. Studies for the U.S. market usually rely on the CRSP tape, which is generally perceived as being of high quality. According to the CRSP data description guide "[c]onsiderable resources are expended in ongoing efforts to check and improve data quality both historically and in the current update. Data corrections to historical information are made as errors are identified […]."[1] The quality of the CRSP tape has been examined by Rosenberg/Houglet (1974), Bennin (1980), Courtenay/Keller (1994), and Shumway (1997). In addition, as indicated by Rosenberg/Houglet (1974, p. 1304) the quality of the CRSP tape is steadily improved by user-initiated corrections. Nevertheless, Shumway/Warther (1999) describe a delisting bias in the CRSP tape and its implication for the size effect. A more recent study that describes data problems in the CRSP tape is Ince/Porter (2006). According to Ince/Porter (2006, p. 472) "CRSP does not reflect the additional shares or the change in market capitalization until the end of the quarter or fiscal year" for seasoned equity offerings.

The situation in terms of data quality and availability for non-U.S. markets is quite different. For most countries Thomson Reuters Datastream (Datastream) and Bloomberg represents the only "easy"

[1] See CRSP, Data Description Guide, CRSP US Stock & US Indices Databases, available at URL: www.crsp.com/documentation/product/stkind/data_descriptions_guide.pdf, January 17th, 2011.

available data sources with a sufficient historical return time series and market coverage. Despite the warning of Ince/Porter (2006), equity data from Datastream became quite poplar in international studies. Among many others, equity data from Datastream for Germany and other countries is employed by Mc Lean et al. (2009), Lee et al. (2009), Campbell et al. (2010), and Fama/French (2011). Some of these studies briefly describe how they screen the data, e.g., Lee et al. (2009, p. 317) state "[t]o reduce errors in Datastream, we follow Hou et al. (2006) and Ince and Porter (2006) in applying a similar screening procedure for international stock returns." In fact, most recent empirical studies rely on the performance of screening techniques to overcome data errors. Very few studies examine the quality of equity data from Datastream. We find that Datastream is less popular in empirical studies for the German market. Schrimpf et al. (2007) for example "use a unique and carefully assembled database for the German stock market, whose quality is unmatched by public data providers such as Datastream." Schmidt et al. (2011, p. 2-3) draw a similar conclusion, and mention that "[i]t is well-known that data from Thomson Reuters Datastream can be prone to errors." Recent studies on the cross-section of German returns by Artmann et al. (2012a, 2012b) and Brückner et al. (2012) also do not use Datastream as the primary data source. Country specific data sets are, however, rare. Jorion/Goetzmann (1999) find only six markets for which non-Datastream total return time series are available. Dimson/Marsh (2001, p. 2) obtain country specific return data for 13 countries. They warn, however, that "the quality of the data varies considerably." For Germany, the Karlsruher Kapitalmarktdatenbank (KKMDB) and a data set maintained by the Centre for Financial Research (CFR) are to our knowledge the only publically available country specific data sets with a sufficient historical time series of German stock returns. The KKMDB is frequently applied as a starting point to create an initial data set. For example, Artmann (2012b, p. 23) obtain "[…] daily stock prices from Karlsruher Kapitalmarktdatenbank (KKMDB) in Karlsruhe, Germany. [They] adjust these prices for dividends, splits, and equity offerings using data from KKMDB and Saling/Hoppenstedt Aktienführer." In other words, they implicitly check and correct the data from the KKMDB for missing return components.

The quality of Datastream has been examined for the U.S. market by Ince/Porter (2006) who document several data errors in Datastream such as coverage issues, return reversals and wrong data for stock splits. However, for non-U.S. markets we still do not have a clear picture of actual data errors in Datastream. For example Ince/Porter (2006, p. 464) state for the U.S. market that "[m]ost of the problems identified in this article are concentrated in the smaller size deciles." This is not ultimately true for Germany depending on the time period one looks at. To address such questions for the non-U.S. markets is relevant since Datastream's data quality varies across countries as indicated by Schmidt et al. (2011). The main contribution to the literature of our paper is to fill this gap for the German market. The German market is usually included in international studies and might be comparable to other developed markets such as the UK and France in terms of Datastream's data quality. We carefully compare equity data from Datastream with our data set for the top segment of the Frankfurt Stock Exchange, the Amtlicher Markt in Frankfurt. We also incorporate alternative "paper based" data sources to detect and verify data errors. In a first step, we check the completeness of the data available from Datastream. We document several coverage issues before 1990. For example, Datastream's coverage of dividends is very low before 1988, increases considerably from 1988 to 1990 and is only sufficient from 1990 onwards. Market coverage, i.e. the number of stocks a total return time series is available from Datastream, is also incomplete before 1990. Additionally, we find a survivorship bias in Datastream before 1990. As a consequence of these problems, we do not recommend Datastream as the primary data source before 1990. After 1990, coverage problems are much smaller, i.e. total return and dividend data are available for most stocks listed in the Amtlicher Markt in Frankfurt. In a second step, we carefully examine the quality of equity data from Datastream for the period from 1990 to 2007. We find random errors in Datastream's time series of the total return index which are caused by incorrect adjustments for dividends and corporate actions. However, between January 1990 and December 2000 we find many return differentials between the two data sources which are caused by price differences, i.e. Datastream's end of month prices do not match with end of month prices from Frankfurt. We also find a considerable number of errors in Datastream's NOSH (number of shares) time series. After 1990 serious data errors are, however, rare for the stocks listed in the top segment of the Frankfurt stock exchange.

Perfect data accuracy is rarely achieved. The required degree of data accuracy may vary considerably across different application types. In a standard analysis of the size effect in Germany we show that the results are robust with respect to the choice of the data source. In principal our data set and data from Datastream yield the same results. Although, Datastream presently does not provide information on the market segment in which a stock is listed. As a consequence, of this weakness one cannot "easily" distinguish between top segment stocks and low segment stocks. This may lead to biases, since the coverage and the data precision may be different for the different segments of the German stock market, which we cannot check with our data. To understand how the inclusion of all German stocks from all German market segments and stock exchanges may affect empirical results, we do a standard analysis of the size anomaly. We demonstrate that the standard way of using Datastream data yields economic inferences on the size anomaly in Germany that differ considerably from Brückner et al. (2012).

Our empirical test builds on the cross-sectional test procedure of Fama/MacBeth (1973). We look at the overall period from July 1975 to October 2007 and two subperiods, July 1975 to June 1990 and July 1990 to October 2007. We choose these subperiods for two main reasons. 1) Before 1990, Datastream is subject to systematic errors. After 1990 the quality of equity data from Datastream is sufficient, especially with respect to market coverage. 2) Looking at these subperiods allows us to replicate the results of Brückner et al. (2012), who document a strong reverse size effect in Germany during July 1990 and October 2007. When using equity data from Datastream we do not find a size anomaly in Germany during the period from 1990 to 2007 when we follow common practice to create test portfolios, i.e. we select data for all German equities and form size decile portfolios, whereby we assign each decile the same number of securities. Only sorts of all German equities from Datastream based on size breakpoints from our data set for the top segment in Frankfurt yields results similar to Brückner et al. (2012), i.e. a reverse size effect during July 1990 to October 2007 emerges. The reverse size effect is strongest when we restrict the sample to the stocks listed in the Amtlicher Markt in Frankfurt.

Our paper distinguishes from Ince/Porter (2006) and Schmidt et al. (2011) in the following ways: First, we do not present any screening techniques to overcome potential data errors. Second, we carefully examine errors in Datastream using a unique data set for the top segment of the Frankfurt stock exchange. This is in light of Ince/Porter who examine data errors in the U.S. using reference data from the CRSP tape. However, neither Ince/Porter nor Schmidt et al. examine data errors for non U.S. markets, which is what we do for the German market. We are also not aware of any paper which does this for the German market or any other non-U.S. market. Third, we summarize German peculiarities that must be considered more carefully in international empirical studies. Forth, we check whether errors occur more frequently among small firms compared to large firms. Finally, we show how empirical results for the size effect in Germany vary with the data set.

The remainder of the paper is organized as follows. Section 2 briefly reviews the relevant literature on data quality. We discuss German peculiarities that need to be considered when creating a data set for the German market in Section 3. In this section we also describe available data sets for the German market in more detail. In Section 4, we evaluate the quality of equity data from Datastream and provide arguments for not using it before 1990. Since we do not recommend Datastream as the primary data source before 1990, we focus primarily on the period from January 1990 to October 2007 in Section 5 to investigate whether Datastream's data quality is sufficient for standard academic use after 1990. In Section 6, we compare market-wide average rates of return across different data sets by replicating popular German all-share stock indices. We also present how empirical results on the size effect in Germany vary across different data sets for the German stock market. Section 7 concludes.

2 Literature Review

Data quality is generally perceived as an important aspect in empirical studies. Nevertheless, there have not been many studies that explicitly address the quality of available data sources. Most of the literature has been written for the U.S. by examining the quality of the CRSP tape and COMPUSTAT. Rosenberg/Houglet (1974) are among the first to systematically examine the quality of available data sources for the U.S. market. They merge monthly price relatives from the CRSP tape with COMPUSTAT to examine differences between the two data sets. They do not consider return discrepancies between 1 and 5 percentage points as serious defects. Altogether they indentify 34 "large discrepancies" (larger than 5 percentage points) between March 1962 and June 1968, which might indicate serious data errors. Only four of these discrepancies were caused by errors in the CRSP tape. The remaining errors were traced back to COMPUSTAT. Rosenberg/Houglet (1974) identify only two kind of errors, errors in recorded prices and errors in the procedures that adjusts returns for stock splits. They miss errors related to dividends, which they were not able to detect since they focus on price relatives instead of rates of return. Bennin (1980) updates the study of Rosenberg/Houglet (1974) for the time period from 1962 to 1978. He compares rates of returns instead of price relatives, thus considering errors in dividends as well. Compared to the aforementioned study he reports significantly lower error rates for COMPUSTAT, thus documenting COMPUSTAT's ongoing efforts to continuously increase data quality. However, according to Bennin (1980) COMPUSTAT's error rate of 1 in 1,000 is still considerably higher than CRSP's error rate of 1 in 10,000 over the years 1962 to 1978. Courtenay/Keller (1994) examine the accuracy of 718 adjustments to prices and number of shares in the CRSP tape for stock splits and stock dividends for the 1yr period from January 1st to December 21st, 1989. Most of the 142 detected discrepancies (e.g. 91 incorrect declarations, 20 ex-date differences) between CRSP and Moody's Dividend Record data, however, do not cause serious problems. Ultimately, they attest to CRSP high accuracy with respect to adjustments for stock splits and stock dividends.

Ince/Porter (2006) are the first to systematically examine the quality of return data from Datastream for the U.S. using reference data from CRSP. They reveal several problems in Datastream. The main problem commences because Datastream does not provide information to "easily" distinguish among different security types. For example, Datastream's equity research lists contain non-equity securities and foreign equities. Naïve use of all securities from these lists, thus, introduces coverage issues. These coverage issues are, however, fixed by the screening techniques of Ince/Porter (2006). The performance of the screening techniques id demonstrated by comparing return data from Datastream with CRSP for size sorted portfolios. Using "raw" data from Datastream yields average equal-weight returns that are generally overstated for small firm portfolios. The screens remove major discrepancies in most size portfolios' average returns. Screening and correcting the data from Datastream yields a statistically significant momentum effect as the CRSP tape. This momentum effect is not detectable using "raw" return data from Datastream. They also find data issues which are caused by wrong dates for stock splits, missing dividends and wrong stock prices. Errors in rates of returns (based on adjusted prices) are additionally caused by Datastream's restriction to report only two decimal places for prices. Thus, the nature of the last problem is a technical constraint.

3 Equity Data for the German Market

3.1 German Peculiarities

Throughout the period from 1973 to 2007, eight stock exchanges existed in Germany (currently seven). During most of this period Frankfurt was by far the most important stock exchange in Germany. Historically, each stock exchange had three market segments (since November 2007 only two), the top segment was the Amtlicher Markt (now the Regulierter Markt). Most stocks are listed at more than one stock exchange and in different market segments. A firm's stock is not necessarily traded on all stock exchanges every day. Not all reported prices result from trades. Usually stock prices differ across stock exchanges, and price differences are typically larger for small and illiquid stocks. As a consequence, monthly returns vary considerably across stock exchanges. Long term holding period returns are, however, not affected by this issue. Nevertheless, possible consequences are average returns (arithmetic mean of monthly returns) that are down-/upward biased and measurement errors in risk measures like beta and standard deviation. To alleviate such problems Brückner et al. (2012) choose prices based on turnover, i.e., they select the price from the stock exchange with the highest turnover on the last trading day of the month. In most cases this is Frankfurt, but there are cases where turnover is higher on other stock exchanges, this is usually the home stock exchange (Heimatbörse).

Empirical studies on the cross-section of German stock returns differ with respect to the stock exchanges and the market segments they include. Stehle (1997), Schulz/Stehle (2002), Schrimpf et al. (2007), Ziegler et al. (2007) and Brückner et al. (2012) focus primarily on the top market segment of the Frankfurt Stock Exchange, the Amtlicher Markt in Frankfurt. Amel-Zadeh (2011) and Hanauer et al. (2011) consider all stocks listed in the German composite index, thus they also focus on Frankfurt, but include firms from the lower market segments, the Geregelter Markt in Frankfurt (*5/1987-†10/2007) and the Neuer Markt (*3/1997-†6/2003) as well. Stocks from the "unofficial" market segments (Open Markt, former Freiverkehr, Geregelter Freiverkehr, Ungeregelter Freiverkehr), which are generally perceived as over-the-counter markets, are usually not considered. Studies that do not explicitly distinguish between the different market segments are Oertmann (1994), Schlag/Wohlschieß (1997), Wallmeier (2000) and Elsas et al. (2003). Some studies for the German market do not clearly distinguish between the different market segments. For example, Artmann et al. (2012b, p. 23) "[…] include all firms listed on the market segments 'Amtlicher Handel' or 'Neuer Markt'. In addition, [they] consider stocks of firms listed on 'Geregelter Markt' if they were listed on 'Amtlicher Handel' or 'Neuer Markt' at any time during [their] sample period." Brückner/Stehle (2012) indicate firms that advance from the Geregelter Markt to the Amtlicher Markt were among the most successful firms ("winners"). As a consequence, the results of Artmann et al. (2012b) and Artmann et al. (2012a), who use the same data set, are probably subject to an ex post selection bias.

The stocks listed in the lower market segments are usually tiny compared to the stocks listed in the top segment. Including the stocks from the lower market segments might increase regression fits due to the higher number of firms per portfolio. However, as a consequence empirical results are dominated by the plentiful, but economically less important tiny stocks from the lower market segments. To overcome this problem one could form portfolios based on Amtlicher Markt breakpoints. This is comparable to commonly applied sorting procedures for the U.S. market. Among others Fama/French (1992) form portfolios based on NYSE breakpoints to avoid portfolios that are dominated by Amex and NASDAQ firms. However, this sorting scheme is difficult to replicate without reliable information about the constituents of German market segments. Alternatively, to avoid empirical results that are dominated by small firms one may use size breakpoints that are percentages of aggregate market capitalization as in Fama/French (2011). Nevertheless, due to the different legal supervision, admission, and listing requirements between the German market segments, empirical results might be subject to a market microstructure effect as described by Reinganum (1990) and Loughran (1993) for the U.S. In addition, empirical results might be affected by the long-run underperformance of IPOs. The lower market segments, especially the Neuer Markt, attracted a considerable number of IPOs. Out of ca. 623 IPOs (in our IPO database) that occurred at the stock exchange in Frankfurt during January 1988 and October 2007, 152 occurred in the Amtlicher Markt, 111 in the Geregelter Markt, 294 in the Neuer Markt (during 3/1997 and 3/2003), and at least 71 in the unofficial market segment.

In Germany, we generally distinguish between common stocks (Stammaktien) and non-voting stock (Vorzugsaktien). Both stock classes are generally considered as equity and should be included in a sample of German equities. However, Vorzugsaktien are usually translated to preferred stocks.[2] Datastream typically adds 'PREF.' or 'PF.' to the name of German non-voting shares and thus classifies them as preference shares. Ince/Porter (2006) suggest to remove preferred shares. This recommendation is usually followed by international studies that include the German market, e.g., McLean et al. (2009), Lee et al. (2009) and Hou et al. (2011). Thus, German non-voting shares are often incorrectly removed from the data set because of Datastream's incorrect classifications. Some German firms have only their non-voting shares listed in Frankfurt, e.g., Porsche AG. Non-voting shares are frequently listed prior to the common shares, e.g., Hugo Boss AG and ESCADA AG. For some firms the common shares are listed first, e.g., Deutsche Lufthansa AG and HeidelbergCement AG. Usually the two share classes are listed at the same time, e.g. Volkswagen AG. Since December 18th, 2009 the non-voting shares of Volkswagen AG are also represented by the most prominent German blue chip index, the DAX. Approximately 80 firms that are listed in the Amtlicher Markt in

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2 See for example Artmann et al. (2012a, 2012b) and Brückner et al. (2012).

Frankfurt during 1970 and 2007 have both share classes listed at the same time. Of these, at least 30 firms converted their non-voting shares into common shares. Thus, incorrectly removing non-voting shares from the data set introduces coverage issues. Sorts on firm size and value-weight returns, where implicitly less weight is assigned to dual class firms, are also affected.

Finally, we do not consider penny stocks, especially when we form portfolios. Some stock exchanges, for example the NASDAQ, delist stocks, which have a permanent stock price of less than $1.00. The Deutsche Börse AG also tried, but failed to delist penny stocks from the Neuer Markt. Ince/Porter (2006, p. 473) "drop all observations in both the TDS and CRSP samples when the end-of-previous-month price is less than $1.00." Schmidt et al. (2011, p. 30) "delete all so-called 'Penny-stocks' with prices less than one unit of the domestic currency." These screens also remove large German firms such as Infineon Technologies AG during December 2008 and March 2009 when the firm's share price was less than €1. Throughout this period the market capitalization was typically well above €300 mln. Another example is YMOS AG, the price of the firm's common shares is typically below €1.00 during the period from January 2004 to October 2007. At the same time the market value is on average €30 mln., which is larger than of many smaller stocks with prices well above €1.00. We classify stocks with prices below €1.00 and market value of equity below €5 mln. as penny stocks. However, we find no penny stocks in our data set before October 2000. From October 2000 to October 2007 we classify on average 5% of the stocks listed in the Amtlicher Markt in Frankfurt as penny stocks. The fraction of penny stocks will increase to 10% if we add the middle market segments, the Geregelter Markt in Frankfurt and the Neuer Markt to the sample.

3.2 German Equity Data from Datastream

In addition to the above discussed issues, five more problems have to be considered when Datastream is used as the primary data source for German stocks.

- First, Ince/Porter (2006, p. 464) find "that the full time series of classification variables often reflect only the most current value." For Germany this means for example the stocks that were initially traded on regional stock exchanges and later switched to Frankfurt are classified as Frankfurt securities. In studies that include all German equities this is not a problem, unless coverage and data quality are lower for the regional stock exchanges. For studies that only look at regional stock exchanges this is not a severe problem either, since securities usually continue their listing in the regional stock exchanges after they are transferred to Frankfurt. Studies that only look at the Frankfurt stock exchange might be subject to a survivorship bias since usually only successful firms eventually start their listing in Frankfurt.
- Second, even though Datastream distinguishes between stock exchanges, it does not distinguish between market segments (at least not in Germany). The research lists cover all German stock exchanges and market segments. Thus, one would include many firms from the lower and unofficial market segments (OTC markets). OTC stocks are typically not included in studies on the U.S. market and in most studies on the Germany market.
- Third, Datastream classifies Frankfurt's floor trading as the primary market in Germany, XETRA is usually classified as the secondary market. XETRA was introduced in November 1997 (replacing the IBIS trading system), since then most trading in stocks takes place in XETRA. Before November 1997 XETRA prices are not available. The classical floor trading

ended on May 23rd, 2011. Datastream usually provides several Datastream identifiers (DSCD) for most stocks, which vary across stock exchanges and currencies. Each DSCD may, however, be considered as a unique identifier for a combination of a stock, stock exchange and currency. We select data primarily from the time series for Frankfurt, data from XETRA or other German stock exchanges are considered only if data (RI, NOSH, UP) is not available for Frankfurt. The research lists, except for the defunct lists, usually include DSCDs for Frankfurt only. DSCDs for XETRA can only be obtained by searching Datastream for all German equities manually. However, searching Datastream for all German equities requires screens which ensure that only one DSCD for each stock is included in the final sample.

- Fourth, the available research lists (FGER1, FGER2, FGERDOM, FGKURS) and defunct lists (DEADBD1 to DEADBD6) for the German market are incomplete. This issue is also pointed out by Ince/Porter (2006, p. 470) for the U.S. market. We find 246 additional stocks when searching Datastream for all German equities (filter: status=all, market=Germany, instrument type=equity, see Table 1). This extended search requires no additional information, but improves coverage considerably.
- Fifth, Datastream reports generally one DSCD per stock class and stock exchange. For some stocks Datastream reports multiple identifiers for the same stock exchange, for example to distinguish between different currencies. Such issues are not necessarily recognized by the common screening techniques, but should be taken into account.

We create two data sets using equity data from Datastream. The first data set is created following common practice in international studies as described in detail by Ince/Porter (2006). We select securities from Datastream's country specific active and defunct research lists. We additionally search for all German securities using the procedure described above. Next, we screen these lists for non-equity securities such as warrants, exchange traded funds, etc. However, we do not remove non-voting stocks which are incorrectly classified as preferred stocks by Datastream. Consolidating the stocks from the aforementioned lists yields a sample of 1,747 German stocks that are listed in Germany during January 1973 to October 2007 (see Table 1). The second data set is created selecting only those stocks that are listed in the top segment of the Frankfurt Stock Exchange during the period from 1973 to 2007. This data set is created using our constituent list for the Amtlicher Markt in Frankfurt. We also use this list to manually search Datastream for stocks that are neither on the research lists nor on the list of all German equities. Stocks that are not listed in the Amtlicher Markt during 1973 and 2007 are not included. The data set includes stocks only for the exact time period during which they are listed in the Amtlicher Markt in Frankfurt. This data set is examined more carefully in Section 4.

[Table 1]

Table 2 provides an overview of data types from Datastream that we consider in our study. For each stock we download the time series of unadjusted prices (UP), adjusted prices (P), and total return index (RI). We also consider the RZ time series, which is an alternative to the RI time series of total returns. In some cases the RZ time series tends to perform slightly better with respect to adjustements for dividends than the RI time series. However, we use primarily the RI time series as most empirical papers do. All DM prices are converted into EURO. We also obtain time series data on dividends (UDDE) and capital adjustments (AX). Dividends that are reported in DM are converted into Euro using the currency information provided by the DCRE time series. We download the number of shares

(NOSH) to estimate companies' market value of equity (UP * NOSH). Looking at NOSH allows us to examine the accuracy of adjustments of the number of shares following corporate actions. Monthly rates of return are calculated from the total return index using end of month levels.

[Table 2]

3.3 Our Data Set for the Top Segment in Frankfurt

The data collection for our data set was initiated by Stehle in 1978. The first version of the data set was completed in 1989 and described by Stehle/Hartmond (1991). The original data set was expanded among others by Schulz/Stehle (2002) and Brückner et al. (2012) until October 2007.[3] The data was obtained from the fact books: Hoppenstedt Kurstabellen (until 1998), the Hoppenstedt Aktienführer (1998-2010), Saling Aktienführer (until 1995), and Handbuch der Deutschen Aktiengesellschaft (1953-1994). Additional electronically available data sources are the Karlsruher capital market database (KKMDB, 1970-2007), Datastream (1973-2007), the Börsenzeitung (Oct. 1998-2007), XETRA Newsboard (1998-2007), and DGAP (1998-2007).[4] Our data set contains all necessary data to calculate monthly total rates of return, i.e. i) the last price of each month, ii) information on dividends, iv) pure stock splits, v) stock dividends, vi) rights issues, vii) reverse stock splits and other financial benefits to the shareholder. Finally, the data set contains the number of shares outstanding which is required to estimate stocks' market capitalization of equity (size) and value-weight portfolio rates of return.

The initial data set includes all German firms where at least one class of shares was listed in the top segment of the Frankfurt Stock Exchange between December 1953 and October 2007.[5] The data set is restricted to the Amtlicher Markt in Frankfurt for two main reasons. First, high quality data for the other stock exchanges are currently not available to us. Second, many empirical studies for the German market also focus solely on the top segment in Frankfurt. In order to avoid any selection bias or survivorship bias, firms are only included for the period for which they were actually listed in the Amtlicher Markt in Frankfurt. IPOs and other new listings are added to the data set at the end of the month of their first listing in this segment. We assume that the data set includes all German stocks for the entire time they are listed in the Amtlicher Markt in Frankfurt. Furthermore, the data set is

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3 Previous versions of the data set were applied by Stehle (1997), Dimson/Marsh (2001), Schrimpf et al. (2007) and Ziegler et al. (2007). The current tape is also applied by Brückner et al. (2012) and Brückner/Stehle (2012).

4 The KKMDB is documented by Bühler et al. (1993) and Herrmann (1996). The data from the Börsenzeitung is available from http://wpi.boersen-zeitung.de. The XETRA Newsboard is provided by the Deutsche Börse AG under http://deutsche-boerse.com. Data from DGAP is available from www.dgap.de.

5 The data set extends back to 1938 for the largest German stocks, which at that specific time, would have been included in the DAX. The DAX is a stock index of the 30 largest firms in terms of market capitalization and turnover.

restricted to common and non-voting stocks only. Profit participation bonds (Genussscheine), and firms that are liquidated, but still exchange listed are not considered.[6]

Stock prices are mainly taken from the Stehle/Hartmond (1991) database until 1988. For the period from 1988 to 2007, 97.87% of the monthly stock prices are from KMDB and 1.97% from Datastream (unadjusted prices, UP). Missing prices are filled with stock prices from the Börsenzeitung and Hoppenstedt Kurstabellen; we primarily select prices from Frankfurt (floor trading). Only if we cannot find an end of month price from Frankfurt we use prices from other stock exchanges. The market value of equity is generally estimated as the product of the stock price and the number of shares outstanding as of the end of each month. The number of shares outstanding was initially obtained by Stehle/Hartmond (1991) and expanded by Schulz/Stehle (2002) and Brückner et al. (2012) until October 2007 using the aforementioned data sources. In addition, we cross-checked the number of shares using information on stock splits, stock dividends, rights issues and reverse stock splits.

We calculate monthly rates of return from the perspective of domestic minority shareholders following the procedure described by Stehle/Hartmond (1991). Thus we adjust monthly rates of return for share reallocations from majority to minority shareholders, and dividends which are only distributed to minority or free shareholders. In this paper we do not take tax refunds (Körperschaftsteuergutschrift) into account. Tax refunds represent a major return component to German shareholders during 1977 and 2000 and should be included as in Brückner et al. (2012).[7] We estimate adjustment factors for stock dividends, pure stock splits, and reverse stock splits according to Sauer (1991). We also take the chronological order of events (in case of multiple events on a single day or during the month) into account when we calculate monthly rates of return.

In contrast to Stehle/Hartmond (1991) and Göppl/Schütz (1995) we use the theoretical value of subscription rights from 1995 onwards, before 1995 we use the first trading price of the subscription rights (if available). Commercial indices such as the CDAX are usually adjusted for the theoretical value of subscription rights. According to Lorenz/Röder (1999) and Dorfleitner/Röder (2002) the theoretical value of the subscription rights overestimates the actual price considerably.[8] Consequently, rates of return are systematically upward biased using the theoretical value. We use the theoretical value of subscription rights from 1996 to 2007, because for this time period the actual prices are not (yet) available to us. The stock indices of the Deutsche Börse AG are also adjusted for subscription

[6] E.g., although, on May 26th, 1966 the shareholders of Riebeck'sche Montanwerke AG decided to liquidate the company, its shares were listed in the Amtlicher Markt in Frankfurt until September 9th, 1982, and afterwards in the unofficial market segment in Frankfurt until 2002. For the same reason we removed Mauser Waldeck AG (liquidated since October 22nd, 2002) and I.G. Farbenindustrie AG (liquidated since February 1st, 1952) from our data set. We also do not consider the "Restquoten" of Commerzbank, Dresdner Bank und Deutsche Bank.

[7] We do not adjust rates of return for tax refunds because Datastream's RI time series does not consider this as well.

[8] Lorenz/Röder (1999) and Dorfleitner/Röder (2002) find that the price of the subscription rights is on average ca. -11.01% to -11.77% lower than the theoretical price for the stocks listed in the Amtlicher Markt.

rights using their theoretical values. We also assume that dividends and the proceeds from selling the subscription rights are reinvested at the end of the month. Datastream like most index providers assumes that dividends and proceeds are reinvested immediately at the (first or closing) price ex dividend or ex subscription right. However, the resulting return differentials are random and should have no implication for long-term rates of return.

3.4 Other Data Sets for the German Market

The University of Karlsruhe provides equity data for the German market, which has become known as the Karlsruher Kapitalmarktdatenbank (KKMDB).[9] The time series of prices extend back to 1960 for 100 German stocks. Data for all German stocks are provided starting in 1974. The KKMDB is frequently applied as a starting point to create a personalized data set for the German market as in Artmann et al. (2012b). The data set of Artmann et al. (2012a, 2012b) is available from the Centre for Financial Research (CFR) at the University of Cologne and described in detail by Artmann et al. (2012b). The data set consists of various equal-weight portfolios, which are formed sorting stocks by size, book-to-market, beta and momentum (one-dimensional) or a combination of two characteristics (two-dimensional). We will consider the data from the CFR in Section 6 when we compare average portfolios returns. Another data set for the German market is provided by Kenneth R. French's data library. The data set contains data for value-weight portfolios of German stocks. Portfolios are formed by book-to-market, earnings-price, cash earnings to price and dividend yield. However, French's data library does not include size-sorted portfolios for Germany, therefore, we cannot use it in our empirical study on the size-effect in section 6. Finally, equity data for the German market is also available from Bloomberg.

4 Quality of Datastream Data before 1990

Currently, equity data (especially total return data) for Germany is not available from Datastream for the period before 1973. According to our data set approximately 629 stocks were listed in the Amtlicher Markt in Frankfurt during the period from 1973 to 2007. Searching Datastream for these stocks yields a list of 588 DSCDs. Table 3 shows that DSCDs are available for all stocks, except for four that were listed in the Amtlicher Markt during 1990 to 2007.[10] Before 1990, however, severe coverage issues, especially in the earlier periods, arise. Datastream lacks 39 (11.54%) identifiers for the period from 1973 to 1990. Consolidating the stocks available from the research lists for the German market (FGER1 and FGER2, FGKURS, and FGERDOM)[11] and the German defunct lists

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9 More detailed information about the KKMDB is available at: http://fmi.fbv.uni-karlsruhe.de/149.php.

10 We were not able to find DSCDs for stocks of BUS Berzelius Umwelt-Service AG, Deutsche Centralbodenkredit-AG, SCOR Deutschland Rückversicherungs AG, and Württembergische AG Versicherungs-Beteiligungsgesellschaft.

11 The two lists FGER1 and FGER2 include the same stocks as the list FGERDOM.

(DEADBD1 to DEADBD6) yields a list of 573 (99.31%) out of the 577 stocks that are listed in the Amtlicher Markt during 1990 to 2007. For the period from 1973 to 1990, the lists include only 299 (88.46%) out of the 338 stocks. Table 3 also indicates that the research lists miss many delisted (inactive or "dead") stocks. To overcome a survivorship bias one has to supplement the data from the research lists with stocks from the defunct lists.

[Table 3]

In a next step we download the time series of the total return index, RI, for each security and compare the available return history from Datastream with the return history from our data set. During the periods from 1973 to 1990 a total return time series is available only for 85.21% of the stocks listed in the top segment of the Frankfurt Stock Exchange. After 1990 a total return time series is available for 98.96% of the stocks. However, during 1973 to 1990, a full total return time series is available only for 61.13% of the stocks listed in the top segment. For 82 securities the RI time series does not cover the full listing period of the security. On average the time series misses total return data for the first 132 listing months during 1973 to 1990. Furthermore, we find a survivorship bias in Datastream before 1990. Only 17 DSCDs are available for the 54 stocks that ceased listing in the top segment in Frankfurt during 1973 to 1990. Total return data is available for 11 stocks only, for two stocks the available total return time series is incomplete. In the words of Ince/Porter (2006, p. 470) "having data for a country in a particular year does not imply that coverage in that year is complete". Finally, Table 8 (which is discussed in more detail in Section 6) indicates that between 1973 and 1990 coverage of small firms is considerably lower than for large firms, thus introducing a selection bias.

The above pattern re-emerges when we compare monthly rates of return across the two data sets for the Amtlicher Markt in Frankfurt. Here we consider only returns that we could merge across the two data sets. Table 4 shows that the fraction of merged returns increases from 67.89% for the period from January 1973 to December 1989 to 99.64% for the period from January 2000 to October 2007. During 1973 to 1990 we cannot match 3,580 (11.62% of merged returns) monthly returns, i.e. monthly return differentials are larger than 1% across the two data sets. The number of "large" return differentials is considerably lower, only 0.96% of the return differentials are larger than 5%. For the period from 1990 to 2007, however, we could not match 15,763 (21.54%) monthly returns. The number of large return differentials of 2,406 (3.29%) is also considerably higher than in the earlier period. This leaves the impression that the quality of the return data is higher during 1973 to 1990. Most return differentials during 1990 to 2007 (especially during 1990 to 2001) are, however, solely caused by price differences across the two data sets. We will return to this issue in Section 5.1.

[Table 4]

We also match dividend data from Datastream and our data set for the firms listed in the Amtlicher Markt between January 1973 and October 2007. Datastream's data type definition of the total return index states that "detailed dividend payment data is only available on Datastream from 1988 onwards." Table 5 shows that between 1981 and 1987, the UDDE time series on average provides dividend data for less than 12.0% of the dividend paying stocks. During 1988 to 1990 dividend coverage of the UDDE time series increases considerably, from 53.5% to 97.0%. As a consequence, we consider dividend coverage of the UDDE time series insufficient for most stocks before 1990. Since 1990 dividend coverage is well above 98% (see Table 5). Even though dividend coverage of the UDDE time series is insufficient before 1990, the total return index, RI, is still adjusted for dividends in many cases when UDDE is void. For most stocks Datastream adds an increment of 1/260th of the annualized dividend yield to the RI time series until 1988. Consequently, we find many return differentials over the month of a dividend payment between Datastream and our data set before 1990. These return differentials are fairly close to average dividend yields from our data set and thus well explained by incorrect dividend adjustments. We are able to match 1,555 dividend yields on an annual basis (monthly dividend yield times 12) across the two data sets for the period from 1973 to 1990. During this period 3,283 dividend payments occurred, of these we are only able to match 351 dividend yields on a monthly basis.

[Table 5]

To summarize the problems, we document important issues of coverage in Datastream before 1990. During the period from 1973 to 1990 we find market coverage with respect to the stocks listed in the top segment of the Frankfurt stock exchange to be insufficient. Dividends are generally not included in the UDDE time series. The total return time series are not properly adjusted for dividends. For these reasons we cannot recommend Datastream as a single source of equity data for the German market before 1990. Market coverage, in terms of available Datastream identifiers, DSCDs, dividend coverage, and availability of total return data increases considerable over time. After 1990 no severe coverage issues arise, i.e. Datastream provides a total return time series for all stocks (except six) that are according to our data set listed in the top segment in Frankfurt during 1990 to 2007. The coverage issues before 1990 have obvious implications for various types of empirical studies. For example you cannot rely solely on equity data from Datastream to measure the performance of IPOs in Germany before 1990. Since total returns are inappropriately adjusted for dividends, abnormal returns might also be biased, especially on the ex dividend day. Long-term market-wide rates of return are, however, not affected as indicated in our empirical section. For the aforementioned reasons we do not examine the quality of Datastream's equity data in detail before 1990.

5 Quality of Datastream Data after 1990

Equity data from 1990 onwards is of better data quality with respect to market coverage and coverage of dividends. However, random errors do occur. To provide a clear picture of actual errors in Datastream's time series we carefully compare equity data from Datastream with data from our data set for the top segment in Frankfurt. We focus on the period from January 1990 to October 2007, when the Amtlicher Markt in Frankfurt was closed. Comparing returns from Datastream's time series of the total return index, RI, with returns from our data sets reveals many return differentials that are larger than 1%. Most return differentials are caused by price differences across the two data sets. We also examine whether Datastream's total return index, RI, is adjusted for dividends and corporate actions such as **p**ure stocks splits and subscription rights. We also document considerable errors in Datastream's NOSH time series. For most mismatches we carefully check which data set reports the correct data. To evaluate mismatches we use data from the aforementioned fact books and electronic data sources. Overall, we find many errors in Datastream's equity data, examples for specific errors are available upon request.

5.1 Prices and Rates of Return

For the period from 1990 to 2007, we find 2,409 (3.29% of returns) return differentials that are larger than 5%, 299 (0.41%) are even larger than 15%. Most monthly return differentials are solely caused by differences in the end of month closing prices; less return differentials occur when we look at non-overlapping quarterly or annual rates of return (geometric means of monthly returns).[12] Table 4 shows that the relative number of return differentials is highest for the period from January 1990 to December 2000, when only 67.54% of the returns from the two data sets match (return differentials are less than 1%). During this period we observe this problem across all size classes, for small firms as well as for large firms such as Allianz AG and BMW AG. The relative number of return differentials is, however, considerably lower for the preceding and succeeding periods, where 88.38% (1/1973 to 12/1989) and 95.53% (1/2001 to 10/2007) of the returns match.

Our data set is based on end of month closing prices from Frankfurt to calculate monthly rates of return. Looking at Datastream data we find that the last change in Datastream's UP and RI time series often occur before the end of the month. As a consequence, 839 monthly return differentials larger than 5% emerge during 1990 to 2007. The majority of these return differentials occur between the nine year period from January 1992 to December 2000, where we find 785 cases. Currently, we cannot explain why the UP and RI time series are not updated for available end of month prices. Possibly, Datastream updates their time series only for trading prices. In contradiction to this hypothesis, we also find end of month trading prices from Frankfurt, which are obviously not considered by Datastream. To elaborate consider the common stocks of the Deutsche Lufthansa AG in April 1990. According to the KKMDB the last trading price in Frankfurt is €91.26 on April 30th, 1990. The last price change in Datastream's UP time series is recorded for April 27th, 1990. Datastream's UP time series reports a price of €93.05 for April 27th, 1990 and for April 30th, 1990.

[12] Ince/Porter (2006, p. 472) also closing prices that deviate between CRSP and Datastream.

Upon further investigation into the data reveals that the RI time series for Frankfurt usually consider stock prices from stock exchanges other than Frankfurt. Datastream's end of month price for the common stocks of Deutsche Lufthansa AG in April 1990, for example, matches the price in Munich on April 27th, 1990. For the non-voting shares of Deutsche Lufthansa AG the last prices in Frankfurt, where trading volume is highest, are €84.72 in February and €103.54 in March 1994. Datastream's UP time series reports €84.21 and €103.79. These prices yield rates of return of 22.2% for Frankfurt and 23.3% for Datastream. In Munich the rate of return would be as high as 24.3% during the month. These return differentials are solely caused by minor differences in stock prices. No dividend or corporate action occurred for Lufthansa AG throughout March 1994. According to the KKMDB the prices from Datastream do not match end of month prices from any German stock exchange. Altogether, we find 26 return differentials for the non-voting shares of Lufthansa AG that are larger than 1%. Twenty-five are solely caused by different prices, one is related to a rights issue in September 1994. This example illustrates that considerable price differences emerge for large German stocks across stock exchanges. For many stocks it remains unclear to us where Datastream's prices come from. Some prices match those reported by Lang & Schwarz AG (OTC market). Currently, Datastream does not provide time series of unadjusted prices, UP, and total returns, RI, for a specific stock exchange. To our knowledge only stock exchange specific time series of adjusted prices, P, are presently available. For Frankfurt this would be the P.FF time series.

We also find time series of unadjusted prices where Datastream's prices hardly match any prices from the KKMDB, e.g., the stock prices reported by Datastream for Victoria Holding AG (only one class of stocks outstanding) do not match prices from the KKMDB (for any stock exchange) for the period from March 1994 to January 1998. Consequently, 44 return differentials larger than 1% emerge, 20 are larger than 5%. Some return differentials are probably caused by technical problems, e.g., the RI time series for Neckarwerke Stuttgart AG. This time series inhabits a severe error if the start date is set to January 1st, 1965 (or before) when downloading the data from Datastream. Until March 22nd, 2002 this time series perfectly matches another time series which we downloaded for this firm setting the start date to December 31st, 1965. From March 22nd to May 19th, 2003 the index levels of the first (biased) time series increase from 835.66 to 21,849,060, the second (correct) index levels increase only to 1076.92. As a consequence, of this technical error, return estimates are heavily upward biased. Common screening techniques might not necessarily recognize such issues.

We would expect most price mismatches and return differentials among small, illiquid stocks (especially for those with a very low free float) and penny stocks. The prices and returns of these stocks usually vary considerably across stock exchanges. However, the number of absolute return differentials larger than 1% does not change considerably across size deciles for the period from 1990 to 2007. In unreported results we observe ca. 4,543 return differentials for the smallest stocks (size deciles D01 to D03) and ca. 4,183 for the largest stocks (size deciles D08 to D10). Only when we look at return differentials larger than 5% we find more deviations across the two data sets among small stocks (1,045) than for large firms (296). Most return differentials are, however, solely caused by price mismatches.

We also examine the performance of one of the screening techniques suggested by Ince/Porter (2006, p. 473-474). They suggest to remove rates of return that are higher than 300% and reversed within one month. We apply this techniques to a list of all German exchange listed equities during the period from January 1990 to October 2007. We find only a single instance, a penny stock with rates of return of -96.25% in May 2003 and 313.41% in June 2003. Altogether, we observe only 48 rates of return that are higher than 300%, out of these 20 observations are observed for penny stocks. For example, the stock price of ISION Internet AG actually increased during April 2003 from €0.21 to €4.00. We also screen for rates of return higher than 100% that are reversed within one month. Screening for such returns yields a list of 161 observations. Most return reversals (ca. 91) are observed for penny stocks, which are usually not considered in empirical studies. Some of the remaining 70 instances are indeed caused by errors in the RI time series.

The above documented price mismatches and return differentials might have implications for event studies, especially for those with small data sets and a relatively large number of small firms. We also expect risk measures such as beta and standard deviation to vary across the two data sets, especially for small firms. For example, for Real AG's stocks (one of the smallest firms) we find five succeeding return differentials above 8% (four higher than 15%) from December 1999 to April 2000. The stock was rarely traded between December 1999 to February 2000, Datastream reports returns of 0% for this time period. The five month holding period returns almost match (difference of only 3.5 percentage points between the two data sets). However, the five-year OLS and Dimson betas for June 2000 differ considerably. We estimate OLS betas of 0.19 (our data) and 0.30 (Datastream). Due to low trading and serial correlation, these OLS betas are downward biased. The difference in Dimson betas (1 lag), 0.52 vs. 0.41, is also considerable.

5.2 Dividend Coverage

During the period from January 1990 to October 2007, we adjust monthly returns for 4,744 dividend payments. We are unable to merge 69 (1.45%) dividends with Datastream's UDDE time series for the following reasons:

- For two dividend payments the payout month differs.[13]
- Datastream's UDDE time series misses pure bonus payments in three cases.

[13] According to our data sources Hugo Boss paid the shareholders of its common and non-voting stock a dividend on June 30th, 1992, whereas Datastream reports July 1st, as the payout date.

- Sixteen dividends are missed because we could not find the Datastream identifier, DSCD, for the dividend paying stocks.
- Forty-eight dividends are not included in the UDDE time series for the Frankfurt Stock Exchange.

For the matched dividends we find 136 (2.86%) dividend payments (incl. bonuses) that differ in their value across the two data sets by more than €0.01.[14] Smaller differences are within the rounding error bounds, probably caused by the DM-Euro conversions and because Datastream reports only two decimal places for dividends. In most other cases UDDE understates the actual dividend payment considerably; compared to dividends from our data set (incl. bonuses) UDDE is on average €1.69 too low. This considerable difference is mainly caused by missing bonuses in Datastream's UDDE time series. Bonus payments are often substantial in Germany; frequently they are higher than the regular dividend. Altogether, ca. 33 bonuses are missed by the UDDE time series. In at least 21 more cases bonuses are only partly reflected. Most bonus payments are, however, fully reflected by the UDDE time series.

Errors in the UDDE time series do not necessarily imply errors in the total return time series. Hence, we also check whether the total return index, RI, is adjusted for dividends. We start comparing dividend yields (*Div.-Yield*) across the two data sets. Dividend yields are calculated as

$$Div.-Yield = \frac{Div_t}{UP_{t-1}} \tag{1}$$

where Div_t represents the dividend (incl. bonuses) from our data set on the ex dividend date t and UP_{t-1} the last cum dividend price on trading day t-1. Additionally, we estimate dividend yields as

$$Div.-Yield^* = \frac{RI_t}{RI_{t-1}} - \frac{P_t}{P_{t-1}} \tag{2}$$

where the dividend yield is derived as the difference in the change in the total return index, RI, and the change in adjusted prices, P. We additionally estimate both measures on a monthly basis. To verify whether dividends are fully reflected by the total return time series we simply need to compare the two dividend yield measures across the two data sets.

Out of 4,744 observations 608 (12.82%) dividend yields do not match during 1990 to 2007, i.e. the difference in dividend yields across the two data sets is on average larger than half a percentage point. Thus, there are problems with dividend yields, even though the UDDE time series reports the correct dividend payment. The 608 problems are caused by:

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[14] We find incorrect dividend yields in 106 cases, when there is an error in the UDDE time series.

- We could not check dividend yields for 7 dividend payments because the total return index or adjusted prices are not available.
- 32 dividend yields are too high.
- 82 dividend yields are too low. Of these 21 dividend yields based on Equation (2) are negative, which is implausible. Dividend yields range between -60% and -100% for 20 observations. These negative yields are mainly caused by errors in the time series of adjusted prices, not in the total return index time series.
- 494 dividends are not considered by the total return index, i.e. the dividend yield from Equation (2) using daily data are virtually zero.

We check whether the above reported 608 mismatches in dividend yields are caused by inappropriate adjustments. Looking at monthly dividend yields (based on end of month prices) result in 235 dividend yields that are fairly close to the "true" dividend yield. Another, 70 dividend yields need to be annualized in order to be close to the true dividend yield. For example, during 1990 to 2007 the dividend yields (based on Equation (2)) of Hugo Boss AG are close to zero. The "true" dividend yields are on average 3.80%. Based on monthly data Equation (2) yields an average dividend yield of 0.24%, which multiplied by 12 yields 3.00% on average. This indicates that in some cases Datastream continues to add an increment of 1/260th of the annualised dividend yield to the RI time series, even though detailed and correct dividend data is provided by the UDDE time series. To mitigate such problems one can alternatively use the RZ time series, which in some cases works slightly better than the more commonly used RI time series for Germany.

Looking at monthly returns for the 608 identified problems in dividends, we find that 183 returns (based on RI) match with our return time series, i.e. the difference in returns is less than half a percentage point. Incorrect dividend adjustments, missed dividends and prices differences across the two data sets account for 425 return differentials that are larger than 0.50%. Based on our results, we do not recommend techniques as proposed by Schmidt et al. (2011), who suggest to divide certain dividends by a factor of ten to recalculate returns for the German market. Finally, we find the quality of Datastream's dividend data to be homogeneous across size sorted portfolios (results not shown). Before 1990 the UDDE time series misses many dividend payments across all size classes. After 1990, the quality of the UDDE time series is generally high. Thus, with respect to dividends we cannot support conventional wisdom that data quality is higher for larger stocks than for smaller stocks.

5.3 Coverage of Corporate Actions

To identify errors that are caused by incorrect adjustments for corporate actions, we compare stocks' monthly returns based on the RI time series with returns from our data set for the month a corporate action occurs. We also consider the AX time series, which provides adjustment factors for corporate actions. Altogether, we consider 1,793 corporate actions during the period from January 1973 to October 2007. In some cases firms implement a combination of corporate actions on a single day. Thus, only 1,713 monthly rates of return are adjusted for corporate actions. For the same period we find 1,414 (82.5%) adjustment factors in Datastream's AX time series. For the period from January 1973 to December 1990, Datastream's AX time series provides 515 (71.2%) out of 723 adjustment factors and for January 1990 to October 2007, 899 (90.8%) out of 1.034. Thus, coverage of corporate actions also increases over time. The low coverage of corporate actions before 1990 is mainly caused by Datastream's insufficient market coverage (see Table 3). For most missed corporate actions in the AX time series the RI time series is also void. Table 6 summarizes information about the 1,034 corporate actions, which must be considered when calculating monthly returns for the period from January 1990 to October 2007. These are 283 pure stock splits, 153 stock dividends, 557 subscription rights and 27 reverse stock splits. This table indicates that compared to the U.S. market rights issues are more common in Germany and have to be considered when calculating total rates of return.

[Table 6]

Most return differentials in the respective month of a corporate action are smaller than 5%. Only 11% of the return differentials are larger than 5%. Nevertheless, we carefully check all return differentials using our aforementioned data sources. Most return differentials are caused by price differences. We find only few errors that are caused by missing or incorrect adjustment factors for pure stock splits, stock dividends and reverse stock splits. The AX time series misses three and reports five incorrect adjustment factors that cause a return differential of more than 1.0%. Thus, coverage of these corporate actions is nearly perfect. We find many errors that are caused by missing adjustments for rights issues. Datastream misses 44 (7.90%) of 557 rights issues, i.e. the AX time series provides no adjustment factor and the change in unadjusted prices, UP, is equal to the change in adjusted prices, P, ($|\Delta P - \Delta UP| < 1.0\%$) over the month when the corporate action occurred. In addition, we find 35 rights issues that are missed by the AX time series, but yield a return differential of less than 1.0%. We also find 124 (22.26%) return differentials that are caused by different values for the subscription rights. These differences either stem from different adjustment procedures (ex date vs. end of month) or differences in the theoretical value (or price) of the subscription rights.

5.4 Number of Shares

Presently, we find 5,811 monthly observations for 164 stocks where the number of shares between our data set and Datastream's NOSH time series differs by more than 10%. For eight stocks (423 monthly observations) NOSH overstates the number of actual shares by a factor of at least five. For example, throughout February 1992 to November 1999 NOSH overstates the number of shares for Walter Bau AG by 39,882k shares when it reports 41,082k instead of 1,200k shares. From December 1999 to May 2001 NOSH overstated the number of shares by a factor of more than two. In June 2001, after the merger of Walter Bau AG and Dyckerhoff & Widmann AG, the number of shares was indeed 41,082k.

Datastream's NOSH time series often reports the total number of shares, thus also including shares that are not exchange listed, e.g., Deutsche Telekom AG during November 1996 to May 1999. There are, however, also cases where NOSH represents only the number of exchange listed shares, e.g., EnBW Energie Baden-Württemberg AG. For some firms this reporting scheme also changes over time, e.g., Pittler Maschinenfabrik AG, where NOSH includes all shares until April 1994, but only the exchange listed shares from April 1994 to October 2007. In some cases such increase/decrease in the NOSH time series might reflect changes in stocks' free float. For example, in February 2000, NOSH changes for Mannesman AG from 500,000k to 48,000k, thus understating the number of shares by a factor of ten until August 2002. This adjustment probably reflects Vodafone's stake of 98.86% in Mannesmann. These observations are puzzling since Datastream provides data types such as NOSHC (number of shares of a company) and NOSHFF (free-float adjusted number of shares), which should consider these issues. However, these time series are usually not available before January 2000 (NOSHC) and April 2002 (NOSHFF).

To obtain a clearer picture of errors in Datastream's NOSH time series, we link data regarding corporate actions to changes in the number of shares, i.e. we check whether Datastream's NOSH time series is adjusted for preceding corporate actions. In more than 90% of all cases NOSH is properly adjusted for changes in the number of shares following corporate actions. Altogether, we find 106 mismatches in the number of shares across the two data sets that are related to corporate actions. We find 26 differences where NOSH is either updated too late (17) or too early (9), 13 where NOSH also includes unlisted shares, 7 for dual class firms, where NOSH does not distinguish between different share classes precisely, and 4 where only the old number of stocks is incorrect. We cannot explain 37 mismatches where NOSH appears to be incorrect according to our data sources. Altogether, 87 differences are caused by errors in Datastream's NOSH time series. For the remaining 19 observations we currently cannot say whether Datastream or our data set provides the correct number of shares as the exact dates of the in-kind contributions (Sacheinlagen) are currently not available to us.

By comparing an old tape (July 2009) with a recent tape (March 2012) of Datastream's NOSH time series we noticed that Datastream changed the number of shares for 48 stocks (2,971 monthly observations) that are listed in the Amtlicher Markt in Frankfurt. Some adjustments introduce errors to the time series. For example, the number of shares of Pilkington Deutschland AG was changed from 2,710k (actual number of shares) to 121k during January 1987 to October 2007. Similar cases occur among others for Nürnberger Beteiligungs AG (2,765k down to 27k shares) and SWARCO Traffic Holding AG (8,840k down to 547k shares). In other cases NOSH is upward adjusted. For example, for TAG Tegernsee Immobilien- und Beteiligungs-AG NOSH was changed from 9k to 56,224k shares during October 1988 and September 1998. For this stock our data set reports 900k shares when the firm was first listed in the Amtlicher Markt in Frankfurt in October 2000, prior to this date the stock was listed in the unofficial market only. As a consequence we would allocate the stock to the portfolio of the largest stocks, D10, whereas it should be assigned to the portfolio of the smallest stocks, D01. Another example is I.G. Farbenindustrie AG where NOSH is changed from 136,000k to 1,360,000k for the period from January 1987 to October 2007. According to our data the number of shares is 13,600k. However, we do not consider the stocks of I.G. Farbenindustrie AG in our sample for the Amtlicher Markt in Frankfurt (see FN 6 for details). The reasons for most changes in the NOSH time series, especially as they introduce errors, remain unclear to us.

6 Empirical Results

6.1 Comparisons of Long-Term Market-Wide Rates of Return

We start replicating the most frequently used stock market indices (official CDAX, DAFOX) to illustrate differences between data from our data set and Datastream. Ince/Porter (2006) use this technique to document the performance of their screens, i.e. compared to raw Datastream data, screened data produces higher correlation coefficients with broad market indices. Schmidt et al. (2011) use this technique to examine the quality of the data from Datastream. However, the limits of this technique are obvious. First, at some point minor increases/decreases in correlation coefficients become meaningless or difficult to interpret. Second, value-weight indices are usually dominated by few large stocks. Hence, having sufficient data quality for the largest stocks yields no inferences about data quality for the majority of small stocks. Annaert et al. (2011) show that a value-weight index of the 20 largest stocks listed on the Brussels Stock Exchange may be considered as a good proxy for an all share index, i.e. average returns are similar and the indices are highly correlated. Third, the composition and methodology of the benchmark indices might change over time. Appendix A provides a discussion of problems that the above mentioned German indices are subject to. Based on these indices it is rather difficult to draw inferences about the quality of a data set. However, our results have implications for the estimation of the market risk premium for Germany.

Table 7 compares average returns on the Stehle/Hartmond-time series (incl. tax refunds), the official CDAX and the DAFOX. The official CDAX performs worst during July 1975 and October 2007, i.e. compared to the Stehle/Hartmond-time series, the CDAX understates the performance of the German stock market by ca. 3.4 percentage points p.a. Different factors, such as insufficient coverage of dividends before 1988, omitted tax refunds, and the disastrous performance of the Neuer Markt after March 2000, cause the poor performance of the CDAX. Average market-wide returns from Datastream and our data set match almost perfectly for the overall period and the two subperiods, 1973 to 1990 and 1990 to 2007. This casts doubt on the high average performance of the DAFOX, which mainly results from the second sub-period, 1990 to 2007. The correlation coefficients with the official CDAX are all very close to unity.

During January 1988 to September 1998, the official CDAX considers all dividends and fully covers the Amtlicher Markt in Frankfurt. For this period our data set yields a rate of return of 14.59%, CDAX yields 14.26%, and Datastream data yields 13.96%. The return on the DAFOX of 15.14% overstates average returns by almost one percentage point p.a. This difference is mainly caused by an error in the

DAFOX time series in 1998. The annual returns over the year 1998 are 15.5% for the CDAX and 18.0% for our return time series. The total return of the DAFOX is, however, 33.0% and thus twice as high as the CDAX return. As a result, we do not recommend the DAFOX time series as a proxy for the German market in empirical studies. Overall, the results suggest that Datastream's data quality is sufficient to estimate long-term, market-wide value-weight rates of return, which is essential to estimate the German market risk premium. Nevertheless, estimates of the market risk premium based on the official CDAX, and Datastream's total return index are too low unless the tax refunds of the corporate income tax on dividends, which German investors received between 1977 to 2000, are considered.

[Table 7]

6.2 Descriptive Statistics and Average Returns for Size Portfolios

Empirical studies for the U.S. market usually assign Amex and NASDAQ securities to portfolios using NYSE breakpoints. Fama/French (2011) argue that this sorting procedure avoids empirical results that are dominated by the plentiful small Amex and NASDAQ stocks. Following this argument, we suggest using breakpoints from the highest market segment in Germany, the Amtlicher Markt in Frankfurt. However, currently Datastream does not provide information on the market segment a stock is listed. Thus, this sorting scheme is difficult to replicate. Looking at portfolios sorted by size we demonstrate how empirical results for the size effect in Germany vary with the data set and the sorting procedure. We consider three different data sources, Datastream, our data and data from the CFR. We create three different sets of size sorted portfolios using data from Datastream. Altogether, we look at five different sets of size sorted portfolios. These portfolio sets differ with respect to the sorting procedure and coverage of the German market.

- DS1) The first data set includes all German equities available from Datastream (see Table 1). Here we assign size portfolios an equal number of stocks.
- DS2) The second data set covers exactly the same stocks; portfolios are formed, however, using size breakpoints from our data set for the Amtlicher Markt in Frankfurt.
- DS3) The third data set is a subset of the first data set. This data set is restricted to stocks that are listed in the Amtlicher Markt in Frankfurt. Portfolios are also formed using size breakpoints from our data set (see Table 3).
- DS4) Our data set for the Amtlicher Markt in Frankfurt is the fourth data set (see Table 3).
- DS5) Finally, we consider equal-weight portfolios sorted by size as provided by the CFR.

We consider the data from the CFR (DS5) only when we compare average portfolio returns. The data from the CFR is described in detail by Artmann et al. (2012b), basically they include primarily stocks from the Amtlicher Markt in Frankfurt and the Neuer Markt. Thus, before March 1990 (when the Neuer Markt was launched) their data set is comparable to our data set in terms of market coverage. From March 1997 onwards their data set is probably more comparable to the data set of all German equities from Datastream.

We form size portfolios at the end of June of year t. Size is measured as the number of shares multiplied with the (unadjusted) price per share. Equal-weight and value-weight portfolio returns are estimated for the time period from July in year t to June in year t+1. We look at two subperiods; the first subperiod extends from July 1975 to June 1990, the second from July 1990 to October 2007. The first subperiod starts in 1975 (not 1973), since we need at least two years of return data to estimate portfolios' pre-ranking rolling betas, which are required for our cross-sectional Fama/MacBeth-test. The number of stocks and the average (equal-weight) market capitalization (in real terms) per portfolio are estimated at the end of June of each year. Table 8 presents time averages over these portfolio characteristics.

[Table 8]

Looking at the average number of stocks suggests that Datastream's coverage of the German stock market during 7/1975 to 6/1990 is lower than we expected. On average only ca. 42% of the stocks that are covered by the KKMDB are in Datastream (not presented). Datastream's coverage of the Amtlicher Markt is considerably higher, on average ca. 69% of the stocks. In Section 4, we find a survivorship bias in Datastream's data for the Amtlicher Markt in Frankfurt before 1990. When comparing the number of stocks per size decile across the two data sets for the Amtlicher Markt in Frankfurt (DS3 and DS4) we also find an omission bias. Datastream's coverage of small stocks (size deciles D01 to D03) is only around 28 to 45%, whereas almost 100% of the large stocks (D08 to D10) are covered by Datastream (see Table 8). As a consequence it is difficult to compare portfolios' average excess returns during the first subperiod, especially for the portfolios of small firms.

During the second subperiod (7/1990-10/2007) the average number of stocks indicates that the Amtlicher Markt in Frankfurt represents on average only 39.34% of all German stocks. However, most stocks from the lower market segments are micro stocks with an average market capitalization of €4 to 107 mln. Sorting all German stocks into size deciles using breakpoints for the Amtlicher Markt in Frankfurt yields small stock portfolios with a relatively large number of stocks. On average the three portfolios of the smallest stocks represent 57% of all German stocks. However, in terms of market capitalization the Amtlicher Markt in Frankfurt represents on average 78% of the German exchange listed equity during 1990 and 2007. During 2000 to 2007, it represents almost 90%.

For the second subperiod all three sets of size sorted portfolios that are formed using Amtlicher Markt breakpoints (DS2 to DS4) yield average excess returns that increase with size. This effect is strongest when we look at the two data sets that solely cover the Amtlicher Markt in Frankfurt (DS3 and DS4). Average return differentials between these two sets of size portfolio are relatively small and not statistically significant. Thus, the aforementioned data errors do not affect average portfolio returns. As in Brückner et al. (2012) we find some evidence of a reverse size effect in raw returns (not adjusted for risk) during the period from 7/1990 to 10/2007. The only portfolio that does not fit into this pattern is the portfolio of the smallest firms, for which we estimate an average return twice as high as for the adjacent portfolio.

Looking at the first data set of all German equities (DS1) yields a completely different return pattern. Portfolios' average excess returns decrease monotonically with size for portfolios D01 to D06, from 12.75% to -3.27%. For portfolios D06 to D10 average excess returns increase almost monotonically, from -3.27% to 5.56%. Thus, indicating a regular size effect among the smallest stocks and a reverse size effect among medium and large stocks. This pattern also emerges, but somehow less pronounced for the size portfolios from the CFR. Excess returns for the CFR size portfolios decrease from portfolio D02 (2.43%) to portfolios D04 (-3.02%) and increase from portfolio D06 (-3.54%) to D01 (6.80%). Compared to the other data sets, average excess returns for the CFR portfolios are generally the lowest. The average excess returns for the portfolio of the smallest stocks in this data set of -0.02% deviates considerably from the other data sets, 3.31 to 12.75%. During the first subperiod the low returns of the CFR portfolios could be induced by coverage issues and insufficient data quality. During the second subperiod the low returns could additionally be explained by the disastrous performance of the stocks from the Neuer Markt after 2000. Currently, we cannot explain the high annualized rate of return of 12.75% when we look at the data of all German stocks available from Datastream.

6.3 Cross-Sectional Results

We use the cross-sectional test procedure of Fama/MacBeth (1973) [FM] to investigate whether equity data from Datastream for the German market yield the same results on the size effect in Germany as our data set for the top segment of the Frankfurt Stock Exchange. We look at monthly excess returns of the size decile portfolios from the data sets DS1 to DS4. We use the natural logarithm of portfolios' average size and portfolios' monthly five year rolling Dimson betas (1 lag) as independent variables. We present results for equal-weight and value-weight portfolios. For equal-weight (value-weight) portfolios we estimate equal-weight (value-weight) independent variables. We look at the full time period from 7/1975 to 10/2007, but also at two subperiods. The first subperiod extends from July 1975 to June 1990, the second from July 1990 to October 2007. We choose these subperiods because of the aforementioned coverage issues in Datastream before 1990. Additionally, choosing these subperiods allows us to compare the results with Brückner et al. (2012), who document a strong reverse size effect for the period from July 1990 to October 2007. Even though we put less weight on results for slopes on Dimson beta, we briefly discuss them to illustrate how economical inferences might differ with respect to the employed data. Table 9 presents the results.

In the first subperiod, the coefficient on size is mostly negative, and insignificant for all three data sets from Datastream (DS1 to DS3) when we look at value-weight portfolios, whereas the equal-weight portfolios yields mostly positive slopes on size, they are also not significant. Our data set for the Amtlicher Markt in Frankfurt (DS4) yields negative slopes on size for equal- and value-weight portfolios. The pricing errors are positive and usually statistically significant across all four data sets when size is the only independent variable. The results for the slopes on size do not change as we add

Dimson betas to the regression model. Thus, size does not explain the cross-section of German returns during the first subperiod. The slopes on betas are positive, but not statistically significant when we look at the two data sets that cover the top segment in Frankfurt (DS3 and DS4). The two data sets that include all German equities (DS1 and DS2) yield positive slopes on beta only for equal-weight portfolios, the slopes on beta are negative for value-weight portfolios, which are also not statistically significant. The pricing errors, however, usually decrease considerably and are not statistically significant anymore across all data sets as we extend the model by beta.

[Table 9]

In the second subperiod, the results differ dramatically across the four data sets. Looking at Datastream's data set of all German equities (DS1) yields negative slopes on size that are not statistically significant. Adding beta to the model yields a slope on size that is positive for equal-weight portfolios (not statistically significant) and zero for value-weight portfolios. The slope on beta is negative and statistically significant at the 10% level when we look at equal-weight portfolios of all German equities (DS1); the pricing error is positive and statistically significant at the 1% level. Sorting the same stocks using size breakpoints from our data set for the top segment yields coefficients on size that are always positive and even statistically significant at the 10% (equal-weight) and 5% (value-weight) level for the model extended by Dimson beta. The pricing errors are not statistically significant anymore. This effect is considerably more pronounced when we restrict the data set to the top segment in Frankfurt (DS3). The slope on size is now positive and statistically significant in all four variations of the test procedure. The slopes on size and the t-values are usually higher for this data set (top segment in Frankfurt) compared to the data sets of all German equities. Both data sets for the top segment (DS3 and DS4) yield slopes on size and t-values that are very similar. It is worth mentioning that if we only look at value-weight portfolios from our data set we observe a positive slope on beta of ca. 1% (annualized), which is not statistically significant. All other data sets and variations in the test procedure yield negative slopes on beta after 1990.

For the overall period we observe negative slopes on size only when we look at all German equities from Datastream (DS1) and use size as the only independent variable. All other data sets and variations in the test procedure yield positive coefficients on size, usually not statistically significant. Equity data from Datastream yields generally negative, statistically insignificant slopes on Dimson beta. Portfolios from our data set yield positive, statistically insignificant slopes on beta.

Overall, the results for the size effect differ considerably for the second subperiod across the four data sets. Size does not explain the cross-section of German returns when we form size decile portfolios of all German equities from Datastream and assign each portfolio an equal number of stocks. This is a sorting procedure that is frequently used in empirical studies on the German market. Following this procedure yields slopes on size that are close to zero and statistically not significant. Using data sets for the Amtlicher Markt in Frankfurt (DS3 and DS4) generally reveals a statistically significant reverse size effect during the period from July 1990 to October 2007. This result is in line with Brückner et al. (2012). Forming portfolios of all German equities using size breakpoints for the top segment yields similar results, but less pronounced. We claim that the difference in the results across the data sets is caused by a regular size effect within the group of the smallest stocks. Within the group of ca. 400 smallest German stocks (deciles D01 to D06 of all German equities, DS1) we find a negative relationship between size and average return for the period from July 1990 to October 2007. Looking at ca. 300 largest German stocks (not all are necessarily large!) listed in the top segment in Frankfurt (D02 to D10, DS4) we find a reverse size effect.

7 Conclusion

Ince/Porter (2006) examine the quality of equity data from Datastream for the U.S. market. We extend upon their work for the German market by comparing equity data from Datastream with equity data from our data set for German stocks listed in the top segment of the Frankfurt Stock Exchange. We document serious and systematic coverage issues in Datastream before 1990. As a consequence, you should not use Datastream as the primary data source before 1990. Only after 1990, when serious data errors are rare, the data quality is sufficient for standard academic use. Nevertheless, we document random errors in Datastream's time series of the total return index that are caused by incorrect adjustments for dividends and corporate actions after 1990. We additionally find a considerable number of price mismatches across the two data sets for the period from January 1990 to December 2000. These price differences mainly occur because Datastream's time series for Frankfurt considers prices from other stock exchanges and/or does not consider end of month closing prices. Consequently, we find many return differentials between the two data sets. We also find important errors in Datastream's number of shares time series. Consequently, the errors in Datastream might have implications for empirical studies that include the German market.

In our Section 6, where we conduct a standard analysis of the size anomaly in Germany, we show that the use of Datastream may yield economic inferences that deviate considerable from previously reported results. Using the FM-test procedure, we find no reverse size effect as in Brückner et al. (2012) when we look at size decile portfolios based on data for all German equities from Datastream. The problem commences because Datastream does not provide information on the market segment a stock is listed in. As a consequence, the plentiful, tiny stocks from the lower and unofficial market segments dominate cross-sectional FM-regressions when we form size decile portfolios. To alleviate results that are dominated by the plentiful, tiny stocks, we advocate the use of size breakpoints from the top segment of the Frankfurt Stock Exchange. A similar procedure is advocated by Fama/French (2011) who form portfolios by sorting the universe of Amex, NASDAQ, and NYSE stocks according to NYSE breakpoints. These and other German peculiarities should be considered when creating a data set that includes Germany.

Furthermore, equity data for Germany, and other developed and emerging markets from Datastream, is frequently used in international studies. Market coverage and data precision for Germany might be comparable to other developed markets such as, Australia, France, Japan and the United Kingdom. Data quality, however, might be considerably lower for emerging markets as for example the Czech Republic, Hungary and Turkey. This issue is also pointed out by Schmidt et al. (2011). Recently, new country specific data sets have been introduced for France and Belgium. Thus, we are awaiting further work on the quality of data from Datastream for other countries. Finally, empirical studies on the cross-section of German returns are usually based on country specific data sets. The results of these studies are difficult to replicate without access to the data or another reliable data source. Artmann et al. (2012a and 2012b) are the first to make their data set publicly available. However, currently little is known about the quality of this data set. Datastream gives us the opportunity to replicate empirical results for time periods from 1990 onward. This should be considered by future empirical studies.

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Appendix A: German Stock Market Indices

In Section 5.1 we tried to draw inferences on the quality of Datastream's equity data by comparing market-wide portfolio returns with the most frequently used German all share stock indices. In this section we briefly discuss problems that these indices are subject to. The official CDAX is one of the most prominent stock indexes for the German stock market. It is a (market) value-weighted index of German stocks that are listed at the Frankfurter Stock Exchange. The index has been calculated by the Deutsche Börse AG since April 22nd, 1993 (official start date). The CDAX was recalculated for the period from December 30th, 1987 till April 22nd, 1993. Before 1988 the official CDAX is based on the FWB-Index. Therefore, the official CDAX time series is available from 1970 onwards. Nevertheless, the following four problems have to be considered:

- The composition of the CDAX changed over time. The official CDAX currently consists of all German stocks listed in the top segment of the Frankfurt Stock Exchange, the Regulierter Markt. This segment resembles the former two official market segments in Frankfurt, the Amtlicher Markt (top segment until 2007) and the Geregelter Markt. Until September 21st, 1998 the CDAX consist only of stocks from the Amtlicher Markt in Frankfurt. Thereafter it also represents the Geregelter Markt and the Neuer Markt, the later was closed in June 2003. [15]
- As a consequence the number of firms represented by the CDAX nearly doubled from 1998 to 2000, most new stocks are IPOs in the Neuer Markt with a disastrous post IPO performance. Foreign stocks, stocks from the Freiverkehr (later Open Market) in Frankfurt and stocks that are not listed in Frankfurt at all have not been represented by the CDAX.
- The official CDAX underestimates the performance of German stocks from 1970 to 1988. This bias is caused by missing dividends and probably by a selection bias before 1988. Both issues are related to the FWB-Index, which was chosen to supplement the official CDAX time series before 1988.
- The CDAX does not consider tax refunds of corporate income taxes paid on dividends, which German investors received between 1977 and 2000. [16] As a consequence the CDAX underestimates the performance of German stocks until 2001. Historical estimates of the

15 Most stocks of the Neuer Markt were transferred to the Geregelter Markt after this market segment was closed, hence the Neuer Markt stocks are also represented by the CDAX after 2003.

16 See Brückner et al. (2012) for a more detailed discussion of this problem.

market risk premium (MRP) based on the CDAX are, therefore, too low. Practitioners, frequently use the Stehle/Hartmond-time series to obtain better estimates of the MRP.

- The calculation of the CDAX was changed in 2002. Before June 24th, 2002 stocks' weights in the CDAX were quarterly estimated based on all shares outstanding. Afterwards weights are adjusted by stocks' free float.

Many studies for the German capital market as Artmann et al. (2012a, 2012b) apply the DAFOX instead of the CDAX. The DAFOX is a well documented performance index of German stocks that are listed in the Amtlicher Markt in Frankfurt.[17] It is available as an equal-weight and a value-weight index. However, the DAFOX is also subject to some problems:

- From 1960 to 1974, the DAFOX does not represent all stocks of the Amtlicher Markt in Frankfurt, which induces a selection bias within this period. This problem arises because before 1974 only ca. 100 stocks are included for which daily prices are available.
- The DAFOX does not include the above mentioned tax refunds, and therefore underestimates the performance of the German stock market.[18]
- The DAFOX is only calculated until 2004. For this reason, it is usually prolonged with the CDAX time series from 2004 onwards as in Artmann et al. (2012a, 2012b).
- The quality of the DAFOX depends on the quality of the underlying data set. The KKMDB (the underlying data set for the DAFOX) is not free of data errors. Thus, the performance of the DAFOX might be biased.

Another well documented and commonly applied proxy for the market portfolio is the Stehle/Hartmond-time series. This time series fully represents the Amtlicher Markt in Frankfurt for the time period from 1948 to 1988. For this time period it includes all financial benefits to stock holders. This time series is prolonged with the official CDAX time series from 1988 onwards. However, in comparison with the official CDAX this time series is fully adjusted for tax refunds.

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17 See Göppl/Schütz (1995) for more details on the DAFOX.

18 The DAFOX covers only stocks that are listed in the AMF. Empirical studies that cover other German market segments or stock exchanges must be aware of the fact that these segments/markets are not represented by the DAFOX. This means that the DAFOX might not be an appropriate benchmark for these studies.

Appendix B: Tables

Table 1: Number of securities in Datastream's constituent lists for the German market.

The table shows the total number of securities in Datastream's research lists for the German market as of March 2012 (before screening). We remove foreign securities, convertibles, subscription rights and new shares (Junge Aktien), and other non equity securities. The last column presents the number of German equities per list (after screening). Equities from the research lists are carefully consolidated and supplemented by missed securities searching Datastream for all German equities (filter: status=all, market=Germany, instrument type=equity). For each stock we obtain the time series of the total return index, RI. Only stocks for which a RI time series is available are included in our final sample of all German equities

Datastream List	Total	Foreign securities	Convertibles	Rights & new shares	Others	German equities
FGER1 & FGER2	1,470	328	9	2	2	1,129
FGERDOM	1,470	328	9	2	2	1,129
FGERKURS	1,618	409	80	3	8	1,118
DEADBD1 to DEADBD6	31,306	28,553	359	173	1,365	856
All German equities	3,904	6	12	186	773	2,927
Stocks on any research list (FGER1 & FGER2, FGERDOM, FGERKURS)						1,139
Additional stocks on defunct list (DEADBD1 to DEADBD6)						847
Additional stocks searching for all German equities						246
Consolidated lists (1/1973-4/2012)						2,232
Final sample (1/1973-10/2007 and RI time series available)						1,747

Table 2: List and Description of the Datastream data types that we consider in our study.

The table presents a list of Datastream data types, including a short description that we consider in our study. We also present some alternative data types that we do not consider due to a sufficient history is not available (e.g. NOSHFF, NOSHC) and/or the definition does not match our needs (e.g. DPS, AF, CAI).

Data type	Description	Alternative data types
DSCD	Datastream's unique identification code for every stock (usually unique per stock, stock exchange and currency).	ISIN
UDDE	Unadjusted individual dividend, sum over all payments on the ex dividend day.	DPS, DD, UDD
DCRE	Currency of the dividend.	DCR
UP	The actual or "raw" closing price.	OP, UP.FF
P	Adjusted price, the closing price adjusted for subsequent capital actions.	P.FF
RI	Theoretical growth in value of a share holding over a specified period. Dividends are assumed to be re-invested at the closing price on the ex dividend date.	RZ, RI.FF
NOSH	Total number of ordinary shares per share class (held separately for dual class firms).	NOSHFF, NOSHC
AX	Adjustment factor (not acumulated) for capital events such as pure stock splits and subscription rights.	AF, CAI

Table 3: Datastream's coverage of German stocks listed in the Amtlicher Markt in Frankfurt, 1960-2007.

The table illustrates the number of stocks included in our data set and Datastream for the stocks listed in the top segment of the stock exchange in Frankfurt during the period from 1/1960 to 10/2007. The overall period is subdivided into three subperiods, 1/1960-12/1972, 1/1973-12/1989, and 1/1990-10/2007. For each period we provide the number of stocks that were (according to our data set) listed in the Amtlicher Markt in Frankfurt for at least one month. The table also provides the number of stocks available from Datastream for each period. We search Datastream's research lists and defunct lists for stocks listed in the Amtlicher Markt in Frankfurt. We additionally query all German equities from Datastream. Manually searching for missing stocks did not result in additional DSCDs. The second panel of the table shows for each subperiod the number of stocks for which a total return time series, RI, is available (at least for one month) and those for which the full return time series is available.

	1/1960-12/1972		1/1973-12/1989		1/1990-10/2007	
Market coverage	Obs.	(in %)	Obs.	(in %)	Obs.	(in %)
Number of stocks in our data set	292		338		577	
Number of stocks in Datastream's:						
- Research lists, excl. defunct list	64	21.92	104	30.77	299	51.82
- Research lists, incl. defunct list	186	63.70	297	87.87	570	98.79
- List of all German equities	187	64.04	299	88.46	573	99.31
Return data coverage of Datastream						
Return time series (RI) available	0	0.00	288	85.21	571	98.96
Full return time series (RI) available	0	0.00	206*	61.13	561**	97.23

* RI time series begins on average 132 month too late. ** RI time series begins on average 26 month too late, this is largely caused by two firms, Otto Stumpf AG (168 month missing) and Escom AG (56 month missing).

Table 4: Monthly return differentials between Datastream and our data set for German stocks listed in the Amtlicher Markt in Frankfurt, 1/1973-10/2007.

The first row (number of returns) presents the number of monthly returns according to our data set for the Amtlicher Markt in Frankfurt. The second row presents the number of monthly returns that we could merge with Datastream. Matched returns illustrates the number of returns across the two data sets that match, i.e. the number of merged returns where the return differential is less than 1%. The bottom part of the table presents the number of return differentials that are larger than 1, 5, 10 and 15%. We subdivide the overall period (1/1973-10/2007) into three periods to illustrate how the number of return differentials varies through time.

	1/1973-10/2007		1/1973-12/1989		1/1990-12/2000		1/2001-10/2007	
	Obs.	(in %)	Obs.	(in %)	Obs.	(in %)	Obs.	(in %)
Number of returns	119,133		45,398		45,151		28,584	
Merged returns	103,992	87.29	30,819	67.89	44,690	98.98	28,480	99.64
Matched returns	84,649	81.40	27,239	88.38	30,200	67.58	27,207	95.53
Return differentials (RD)								
RD >= 1%	19,343	18.60	3,580	11.62	14,490	32.42	1,273	4.47
RD >= 5%	2,701	2.60	295	0.96	1,958	4.38	448	1.57
RD >=10%	756	0.73	81	0.26	477	1.07	198	0.70
RD >=15%	333	0.32	36	0.12	203	0.45	94	0.33

Table 5: Average number of dividends, dividend yields and return differentials in dividend payout months of German stocks traded in the Amtlicher Markt in Frankfurt, 1/1973-10/2007.

The table compares the number of dividend payments, dividend yields and return differentials in dividend payout months between our data set and data from Datastream for German stocks listed in the Amtlicher Markt in Frankfurt. We look at different time periods during 1973 and 2007 to show how Datastream's coverage of dividend payments improves over time. For our data set we show the average number of dividend payments and dividend yields (D/UP) per year. D denotes the dividend (incl. bonuses) and UP denotes Datastream's unadjusted price on the cum dividend day. Looking at dividend data from Datastream we present the average number of dividends per year in the UDDE time series for German stocks listed in the Amtlicher Markt in Frankfurt and the fraction of dividend payments according to our data set (in % of AM). We present average dividend yields per year which are based on data from Datastream using two different dividend yield measures, UDDE/UP and dRI-dP. UDDE is the dividend from Datastream. The latter measure is based on the monthly differences between the change in the total return index (dRI) and the change in the adjusted prices (dP). This measure considers only observations where dRI is larger than dP. The two measures consider only stocks for which Datastream's UDDE time series is not void. The last two columns show average return differentials per year between the two data sets. Return differentials are estimated as the difference between the monthly rate of return from our data set and the change in the total return index from Datastream. To calculate this measure we consider only months for which (i) our data set reports a dividend payout and (ii) we can calculate a monthly rate of return using Datastream's RI time series over the month of the dividend payment.

	Amtlicher Markt		Datastream				Return Differentials	
Period	Number of dividends	D/UP (in %)	Number of dividends	in % of AM	UDDE/UP (in %)	dRI-dP (in %)	Number of RDs	R-dRI (in %)
1/1973-12/1980	183.4	3.39	-	-	-	-	115.75	3.22
1/1981-12/1987	189.1	2.79	21.9	11.56	2.89	2.89	133.14	2.36
1/1988-12/1988	243.0	2.63	130.0	53.50	2.50	2.36	177.00	1.33
1/1989-12/1989	250.0	2.19	162.0	64.80	2.19	2.63	246.00	0.74
1/1990-12/1990	269.0	1.99	262.0	97.40	1.95	2.69	264.00	0.10
1/1991-12/1999	283.1	2.58	278.9	98.51	2.53	2.69	282.78	0.03
1/2000-10/2007	220.3	3.25	218.6	99.26	3.24	3.04	219.88	0.19

Table 6: Relevant capital adjustments, 1/1990 – 10/2007.

The table presents capital actions (pure stock splits, stock dividends, subscription rights, reverse stock splits, and others) for all German stocks listed in the Amtlicher Markt in Frankfurt during the period from January 1990 to October 2007. Obs. represents the number of observation for each group of capital actions. For each observation we compare monthly rates of return over the month of the capital action using data from Datastream, RI, and our data set. Panel A provides the absolute and relative number of return differentials within each event group that are larger than 1.0, 5.0, and 10.0%. The last column in Panel A states the average return differential over all events within an event group. Panel B provides information on what causes return differentials larger than 1.0%. Possible sources are different prices, different adjustment factors, or missing adjustment factors in Datastream. Return differentials that are not solely explained by different stock prices or adjustment factors are summarized in the last column of Panel B.

Panel A: Number of absolut return differentials higher than 1.0%, 5.0%, and 10.0%.

Capital action	Obs.	$\|RD\| \geq 1\%$		$\|RD\| \geq 5\%$		$\|RD\| \geq 10\%$		Avg. RD
Pure stock splits	283	102	36%	30	11%	11	4%	0.54%
Stock dividends	153	38	25%	11	7%	1	1%	0.15%
Rights issue	557	221	40%	57	10%	20	4%	-0.23%
Rev. stock splits	27	14	52%	13	48%	9	33%	-5.42%
Others	3	-	-	-	-	-	-	-
Total	1028	375	36%	111	11%	41	4%	

Panel B: Absolut return differentials higher than 1.0% and their cause.

	Obs.	Different Price		Different Adj. Factor		Missing Adj. Factor		Other	
Pure stock splits	102	82	80%	2	2%	1	1%	17	17%
Stock dividends	38	27	71%	2	5%	1	3%	8	21%
Rights issue	221	24	11%	124	56%	44	20%	29	13%
Rev. stock splits	14	2	14%	1	7%	1	7%	10	71%

Table 7: Comparisons of average market-wide rates of return, 1/1975-10/2007.

The table compares average annualized rates of returns (in %) of the most frequently used German all share indices (Stehle/Hartmond-time series, the official CDAX and the DAFOX) and market-wide value-weight portfolios formed using data from Datastream and our data set. The DAFOX is expanded for the period from 1/2005 to 10/2007 with the official CDAX. We look at two data sets from Datastream, the first considers all German equities (TDS, Germany), the second only those equities that are listed in the Amtlicher Markt in Frankfurt (TDS, Amtlicher Markt). Our data set also considers only stocks listed in the top segment of the Frankfurt stock exchange, the Amtlicher Markt. We subdivide the overall period from 1/1975 to 10/2007 into two subperiods (7/1975-6/1990 and 7/1990-10/2007). In addition, we consider the period from 1/1988 to 9/1998 when the CDAX considers only stocks from the Amtlicher Markt in Frankfurt and includes all dividends.

	7/1975-10/2007	7/1975-6/1990	7/1990-10/2007	1/1988-9/1998
Data set	Average annualized rate of return (in %)			
Stehle/Hartmond	12.21	14.63	10.12	15.32
Official CDAX	10.31	11.23	9.52	14.26
DAFOX	12.00	13.15	10.99	15.14
TDS, Germany	11.06	13.05	9.33	13.87
TDS, Amtlicher Markt	11.40	12.98	10.03	13.96
Our data, Amtlicher Markt	11.58	13.11	10.25	14.59
	Correlation with CDAX			
DAFOX	0.9775	0.9911	0.9812	0.9888
TDS, Amtlicher Markt	0.9829	0.9822	0.9933	0.9944
Our data, Amtlicher Markt	0.9826	0.9908	0.9882	0.9962

Table 8: Descriptive statistics and equal-weight excess rates of return for size sorted decile portfolios, 7/1975-10/2007.

The table presents descriptive statistics (average number of stocks, average market capitalization in prices of 2007) and average excess returns (portfolios' return less the risk-free rate, SU0104, annualized, in percent) for different size sorted portfolios for the German market. We look at five different data sets, DS1 to DS5. DS1) Datastream data for all German equities. DS2) Datastream data for all German equities sorted using size breakpoints. DS3) Datastream data for German stocks listed in the Amtlicher Markt in Frankfurt sorted using size breakpoints. DS4) Our data set for the Amtlicher Markt in Frankfurt. DS5) Data from the CFR (CFR, only average returns available to us). We form ten size portfolios at the end of June of every year t. Size is measured by a stock's market value of equity at the end of June in year t (number of shares multiplied with the stock price). We assign the same number of stocks to each size decile for data set DS1 and DS4. The number of stocks per size portfolio differ for data sets DS2 and DS3 due to the use of size breakpoints. The size breakpoints are estimated from our data set for the Amtlicher Markt in Frankfurt. Equal-weight portfolio returns are calculated for the period from July in year t to June in year t+1. The data from the CFR is described in detail by Artmann et al. (2012b). We present results for two subperiods, 7/1975-6/1990 and 7/1990-10/2007.

	7/1975-6/1990										7/1990-10/2007									
	D01 (Small)	D02	D03	D04	D05	D06	D07	D08	D09	D10 (Large)	D01 (Small)	D02	D03	D04	D05	D06	D07	D08	D09	D10 (Large)
Data set	Average number of stocks										Average number of stocks									
DS1) TDS, all German stocks	30.9	26.4	26.4	26.4	26.4	26.4	26.4	26.4	26.4	26.4	88.8	84.8	84.7	84.8	84.8	84.8	84.8	84.8	84.8	84.8
DS2) TDS, all German stocks, breakpoints	38.9	26.4	24.9	22.3	28.9	26.8	23.3	24.1	25.4	26.3	282.8	119.7	84.1	68.4	61.2	57.7	54.3	43.7	41.4	37.9
DS3) TDS, top segment, breakpoints	7.9	10.2	10.3	13.9	17.6	16.6	18.8	21.6	21.2	23.3	33.6	35.7	34.0	32.1	32.1	32.4	33.8	34.1	34.1	34.0
DS4) Our data, top segment	26.5	22.4	22.4	22.3	22.4	22.4	22.4	22.4	22.4	22.4	38.1	33.6	33.6	33.6	33.6	33.6	33.6	33.6	33.6	33.6
	Average market capitalization (in mln. Euro, real)										Average market capitalization (in mln. Euro, real)									
DS1) TDS, all German stocks	17	48	88	127	181	273	435	639	1,257	5,535	4	12	24	41	66	107	183	344	823	9,170
DS2) TDS, all German stocks, breakpoints	12	37	70	113	166	250	408	612	1,115	4,972	15	51	89	145	228	366	627	1,187	2,748	16,186
DS3) TDS, top segment, breakpoints	16	37	72	114	165	255	407	613	1,117	4,493	21	52	90	147	230	368	636	1,196	2,767	16,535
DS4) Our data, top segment	14	38	71	113	166	258	410	613	1,156	5,219	20	53	90	148	231	370	642	1,202	2,800	17,600
	Average equal-weight excess return (annualized, in %)										Average equal-weight excess return (annualized, in %)									
DS1) TDS, all German stocks	6.56	7.49	6.93	8.00	7.42	8.35	8.26	6.33	5.53	7.49	12.75	2.92	2.54	1.39	-1.02	-3.27	0.83	-0.23	3.75	5.56
DS2) TDS, all German stocks, breakpoints	3.82	8.23	7.06	6.96	9.08	5.74	10.93	6.28	5.77	7.05	6.19	0.76	-2.31	-0.82	2.83	0.52	2.70	2.09	6.48	5.03
DS3) TDS, top segment, breakpoints	7.76	6.09	10.24	9.45	7.28	6.14	10.52	6.26	5.77	7.21	3.45	0.30	-1.55	0.80	4.69	3.81	4.34	4.89	6.42	7.03
DS4) Our data, top segment	10.15	7.07	8.15	6.91	7.46	6.22	9.06	5.45	6.27	7.24	3.39	-0.79	-0.79	1.19	5.28	4.03	5.13	4.82	6.11	7.65
DS5) CFR	8.60	5.61	6.80	6.04	6.61	7.25	8.02	6.81	6.96	5.22	-0.02	2.43	-2.65	-3.02	-2.34	-3.54	-0.90	-1.41	4.60	6.80

Table 9: Results for cross-sectional Fama/MacBeth regressions for one-dimensional sorted size decile portfolios, 7/1975-10/2007.

The table presents average intercepts (annualized alphas in %) and slopes on portfolio characteristics (also annualized in %) from monthly cross-sectional Fama/MacBeth regressions of excess returns on size and beta. We present results for equal-weight and value-weight size portfolios (ten portfolios). We use monthly excess rates of return as a dependent variable in the regressions. The independent variables are determined by a portfolio's average size and 5-yr rolling beta. Monthly Dimson betas are estimated regressing 60 (at least 24) monthly portfolio excess returns on the market excess return and one-month lagged market excess return. We look at the overall period from 7/1975 to 10/2007, as well as two subperiods, 7/1975-6/1990 and 7/1990-10/2007. The t-values for the intercepts and slopes are presented in parentheses. T-values above/below ± 1.96 are highlighted.

7/1975-10/2007						7/1975-6/1990						7/1990-10/2007					
Equal-weight			Value-weight			Equal-weight			Value-weight			Equal-weight			Value-weight		
Alpha	Beta	Size	Alpha	Beta	Size	Alpha	Beta	Size	Alpha	Beta	Size	Alpha	Beta	Size	Alpha	Beta	Size
1) Datastream data for all German equities																	
5.99		-0.23	6.16		-0.17	7.57		0.03	8.94		-0.27	4.62		-0.45	3.74		-0.09
(1.71)		(-0.70)	(1.64)		(-0.48)	(1.53)		(0.06)	(1.91)		(-0.57)	(0.92)		(-1.02)	(0.64)		(-0.17)
8.52	-7.98	0.38	6.54	-1.40	0.04	4.10	3.53	0.29	8.55	-0.67	0.08	12.34	-17.93	0.46	4.80	-2.03	0.00
(1.81)	(-1.00)	(0.84)	(1.28)	(-0.18)	(0.09)	(0.50)	(0.37)	(0.55)	(1.03)	(-0.08)	(0.17)	(2.19)	(-1.53)	(0.68)	(0.76)	(-0.17)	(0.00)
2) Datastream data for all German equities, sorted using breakpoints from our data set for the Amtlicher Markt in Frankfurt																	
2.53		0.41	3.20		0.36	6.54		0.24	8.03		-0.08	-0.94		0.56	-0.97		0.73
(0.68)		(1.22)	(0.86)		(1.04)	(1.27)		(0.52)	(1.64)		(-0.17)	(-0.17)		(1.26)	(-0.18)		(1.55)
1.41	-1.51	0.75	7.03	-6.10	0.58	-0.09	6.50	0.47	11.70	-4.05	-0.01	2.72	-8.45	0.99	2.98	-7.87	1.09
(0.34)	(-0.28)	(1.92)	(1.60)	(-1.19)	(1.48)	(-0.01)	(0.79)	(0.93)	(1.52)	(-0.51)	(-0.02)	(0.64)	(-1.18)	(1.71)	(0.65)	(-1.16)	(1.99)
3) Datastream data for the Amtlicher Markt in Frankfurt, sorted using breakpoints from our data set for the Amtlicher Markt in Frankfurt																	
2.63		0.50	4.04		0.26	9.40		-0.24	11.21		-0.59	-3.23		1.14	-2.17		0.99
(0.69)		(1.31)	(1.06)		(0.63)	(1.72)		(-0.43)	(2.09)		(-0.99)	(-0.60)		(2.52)	(-0.39)		(1.86)
-0.71	-0.20	0.90	-0.56	1.19	0.65	1.65	5.19	0.27	1.99	7.00	-0.15	-2.76	-4.86	1.44	-2.76	-3.83	1.35
(-0.18)	(-0.04)	(2.06)	(-0.14)	(0.23)	(1.45)	(0.27)	(0.95)	(0.45)	(0.31)	(1.14)	(-0.24)	(-0.56)	(-0.60)	(2.37)	(-0.49)	(-0.47)	(2.06)
4) Our data for the Amtliche Markt in Frankfurt																	
2.77		0.45	2.49		0.50	9.88		-0.41	8.06		-0.13	-3.39		1.20	-2.33		1.04
(0.76)		(1.24)	(0.69)		(1.31)	(2.28)		(-0.80)	(1.86)		(-0.24)	(-0.61)		(2.52)	(-0.41)		(1.98)
-0.79	1.32	0.65	-2.13	3.18	0.65	1.50	9.76	-0.53	2.10	5.65	-0.04	-2.77	-5.99	1.67	-5.80	1.05	1.24
(-0.20)	(0.23)	(1.50)	(-0.52)	(0.55)	(1.48)	(0.23)	(1.19)	(-1.01)	(0.33)	(0.68)	(-0.07)	(-0.57)	(-0.77)	(2.68)	(-1.12)	(0.12)	(1.84)